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(Continued)

JOINT SESSION OF THE ENTOMOLOGICAL SOCIETY OF ONTARIO AND THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Friday, December 30, 1921, 1.30 p. m.

President Dean presided while four papers were being presented and discussed that were left over from the program of the previous afternoon. At the close of these papers, Mr. Arthur Gibson, President of the Entomological Society of Ontario, presided during the rest of the session.

PRESIDENT GEORGE A. DEAN: The first paper is by P. A. Glenn.

RELATION OF TEMPERATURE TO DEVELOPMENT OF THE CODLING-MOTH

By P. A. GLENN, *Chief Inspector, Division of Plant Industry, State Department of Agriculture, Urbana, Illinois*

The purpose of this paper is to give briefly some of the results of a study recently made of the relation of climatic conditions to the development of the codling-moth and especially to the time of appearance of the several broods of the moth. The study is based upon data collected during a period of three years, 1915, 1916, 1917 at three localities in Illinois.

The purpose of the study was to find some temperature unit so related to development that the sums of these units which accumulate

during the period of any stage of the insect would be the same for all temperatures.[1]

The unit of temperature used is the day-degree. It may be defined as a temperature of one degree acting for a period of one day.

Table 1 gives the results of the studies on the incubation period based upon observations on 4175 eggs.

TABLE 1. TEMPERATURE AND THE INCUBATION PERIOD OF THE CODLING-MOTH

MEAN DAILY TEM	PER-IOD	DAILY DAY-DEG. +50°	DAILY DAY-DEG. 2(+88°)	DAILY DAY-DEG. +50°–2(+88°)	TOTAL D.DEG. +50°	TOTAL D.DEG. +50°–2(+88°)
61.60	14.00	12.30		12.30	172	172
63.11	12.67	13.31		13.31	170	170
64.94	10.66	15.13		15.13	161	161
67.48	9.35	17.47		17.47	163	163
69.01	8.67	19.01		19.01	165	165
71.33	7.72	21.33		21.33	165	165
73.12	7.00	23.12	.01	23.11	162	162
74.86	6.60	24.86	.45	24.41	164	161
77.43	6.12	27.43	.96	26.47	165	159
78.71	5.95	28.71	.96	27.75	171	165
80.14	5.71	30.14	1.93	28.21	172	161
82.86	5.52	32.86	3.74	29.12	181	161
84.00	5.53	34.00	4.66	29.34	188	162
	7.67	21.70		21.33	166	163

The average mean daily temperatures which prevailed during these observations varied from 61.6 to 84 deg. Fahr. and the periods from 14 to 5.52 days. Development of the egg proceeds only at temperatures above 50 deg. Fahr. The rate of development increases as the temperature rises above 50 deg. until it reaches 88 deg. at which point development is at the maximum rate. The third column gives the average daily day-degrees above 50 deg. and column 6 gives the product of the day-degrees in column 3 by the periods in column 2. These products are fairly uniform for the lower temperatures,[2] but increase at the higher temperatures, because during the warmer part of the season the temperature for a part of the time was above 88 deg. and the day-degrees in column 3 contain some day-degrees above 88 deg., which retard development. To make the needed correction in the day-

TABLE 2. TEMPERATURE AND THE LARVAL PERIOD OF THE CODLING-MOTH

MEAN DAILY TEM.	PER-IOD	DAILY DAY-DEGREES +50°	DAILY DAY-DEGREES 2(+88°)	DAILY DAY-DEGREES +50°–2(+88°)	TOTAL DAY-DEG +50°	TOTAL DAY-DEG +50°–2(+88°)
69.45	35.37	19.45	.34	19.11	692	680
70.58	32.29	20.58	.30	20.58	674	665
73.48	29.20	23.48	.72	22.76	686	665
74.53	28.22	24.53	.74	23.79	702	681
76.74	27.14	26.74	.90	25.34	726	688
79.39	25.93	29.39	3.62	25.77	762	668
80.30	26.35	30.30	4.36	25.94	798	683
74.31	29.07	24.31		22.75	719	673

[1]Humidity and evaporation under out-of-door conditions have such a slight effect upon the rate of development that for practical purposes they may be disregarded.

[2]An exception should be noted in the case of the total day-degrees when the mean daily temperatures averaged 61.6 and 63.11 degrees. The total day-degrees at these temperatures are greater than at other temperatures. This indicates that possibly the threshold of development is greater than 50 deg.

degrees on account of temperatures above 88 deg. twice the day-degrees above 88 were subtracted from the day-degrees above 50. This gave the effective day-degrees recorded in column 5. Multiplying the day-degrees in column 5 by the periods in column 2, we get the sums of day-degrees, or the total day-degrees, recorded in column 7, which are quite uniform for all temperatures.

Proceeding with the data on the larval period as we did with the data on the incubation period, we find that if twice the number of day-degrees above 85 be subtracted from the day-degrees above 50, we shall have temperature factors in column 5, which when multiplied by the periods in column 2, give products which are fairly uniform in size. The number of larvae observed was comparatively small, being only 344, and the wider variation in the products as compared with the products in the table of data on the incubation period is due to this fact. It is generally true that the greater the number of observations the more nearly does the average of the products approach a constant.

TABLE 3. TEMPERATURE AND THE PUPAL PERIOD OF THE CODLING-MOTH

MEAN DAILY TEM	PERIOD	DAILY DAY-DEG. +52°	DAILY DAY-DEG. 2(+87°)	DAILY DAY-DEG. +52°−2(+87°)	TOTAL DAY-DEG +52°	TOTAL DAY-DEG +52°−2(+87°)
52.60	45.50	5.19		5.19	236	236
55.70	35.20	6.80		6.80	238	238
56.15	34.01	7.08		7.08	241	241
58.30	22.77	8.69		8.69	241	241
69.28	13.80	17.31		17.31	239	239
70.79	12.70	18.79	.04	18.75	239	239
73.11	11.51	21.11	.24	22.87	243	240
74.92	10.73	22.92	.42	22.50	246	241
76.77	10.02	24.77	.88	23.89	248	239
79.14	9.44	27.13	1.63	25.50	256	241
80.88	9.43	28.88	3.52	25.36	272	239
82.68	9.24	30.68	4.12	26.56	284	245
	14.99	17.38	.77	16.61	252	241

The above table is based upon observations on 3817 pupae. To secure temperature factors for the pupal stage which when multiplied by the periods would give nearly the same results for all temperatures, it was necessary to subtract twice the day-degrees above 87 degrees from the day-degrees above 52 degrees.

We concluded therefore, that the threshold of development for the egg and larva is approximately 50 deg. Fahr. and for the pupa approximately 52 deg. Fahr., and the degree of the maximum rate of development for the egg is about 88 deg. Fahr., for the larva 85 deg. Fahr., and for the pupa 87 deg. Fahr., that the effective day-degrees for any day may be found by subtracting twice the day-degrees above the degree of the maximum rate of development from the day-degrees above the threshold of development, and that the sum of the daily day-degrees for all the days in the period will be the theoretical thermal constant. This constant in the case of the incubation period is about 163, the larval period 673, and the pupal period 241, (265 if 50 deg.

Fahr. be taken as the threshold of development.[3]) The sum of the effective day-degrees is not a constant in individual cases, but the average of the sums in a large number of observations approaches a constant.

Variations from the average were comparatively large in individual cases. These were due partly to the use of the day as the unit of time, partly to local conditions by reason of which the temperature of the specimen was not always the same as that of the recording instrument, possibly partly to humidity and evaporation, and in the case of the larva to differences in the character of food.

After all allowances were made for variations caused by factors which were measurable, the variation in the sums of effective day-degrees which must be attributed to other causes were for the incubation period from about 156 to 170, for the larval period from about 527 to 873 and for the pupal period from about 256 to 274. Adding these together we have for the three periods a minimum of 939, an average of 1101 and a maximum of 1317.

From a computation of the sums of effective day-degrees for the entire development period of over 200 individuals kept under observation from the dates when the eggs were laid to the dates when the adults emerged, using 50 deg. as the threshold of development and 86 deg. as the degree of maximum rate of development, the minimum sum was about 950, the average 1120 and the maximum about 1350.

Data on the seasonal history were secured by noting the dates of appearance of the first eggs, larvae and adults of the several generations and computing the total number of effective day-degrees that had accumulated on these dates after January 1. The average accumulations are shown in the following table, each of the averages being based upon from 4 to 7 observations:

TABLE 4

	Effective day-degrees
1st pupa of hibernating generation	109
1st adult of " "	339
1st egg of first "	406
1st larva of " "	578
1st pupa of " "	1074
1st adult of " "	1308
1st egg of second "	1414
1st larva of " "	1551
1st pupa of " "	2169
1st adult of " "	2387
1st egg of third "	2471
1st larva of " "	2632

[3]For practical purposes it is necessary to use the same threshold of development for the pupa as for the egg and larva. If 50 deg. is used for the pupa instead of 52, the sums of the effective day-degrees will be 265.

Owing to the comparatively small number of observations used in making the above averages the results are not very consistent. They show an average accumulation of 1027 day-degrees for the complete life cycle; that is, from egg to egg, larva to larva, etc. In making the observations no doubt the first individuals were not noted in every case, consequently 1027 day-degrees is probably greater than the actual number that accumulate between the time of appearance of the first individuals of one brood and the first individuals of the next brood.

The minimum accumulation of effective day-degrees during the development period found by adding the minimum for the egg, the larva, and the pupa was 939, the minimum found by treating the entire development period as one period was 950. To get the minimum accumulation for the complete life cycle, we add 50 day-degrees to each of the above to allow for the accumulation during the time which elapses between the date of emergence of the moth and the date of egg deposition. This gives 989 and 1000 respectively as the minimum accumulations for the complete cycle. The average of these three minimums, 989, 1000 and 1027 is 1005. Therefore, after the first individuals of one brood appear we may expect the first individuals of the next brood to appear when 1000 effective day-degrees have accumulated. An equitable distribution of these 1000 effective day-degrees between egg, larva, pupa, and the interval between the emergence of the adult and the deposition of the first eggs would be 158, 532, 260, and 50 respectively. Now if we revise table 4 so as to make it consistent with the above distribution of effective day-degrees, we have the approximate number of effective day-degrees which will have accumulated at the time of the appearance of the first individuals of each of the broods during the season. These are shown in table 5.

TABLE 5.—APPROXIMATE NUMBER OF EFFECTIVE DAY-DEGREES WHICH WILL HAVE ACCUMULATED WHEN THE FIRST INDIVIDUALS OF EACH BROOD APPEAR.

	Effective day-degrees
1st pupae, hibernating generation	82
1st adults, " "	342
1st eggs, first "	392
1st larvae " "	550
1st pupae " "	1082
1st adults " "	1342
1st eggs, second "	1392
1st larvae, " "	1550
1st pupae, " "	2082
1st adults " "	2342
1st eggs, third "	2392
1st larvae, " "	2550

We believe that table 5 shows quite accurately the relation between temperature and the time of appearance of the first eggs, larvae, pupae and adults of the three generations of the codling-moth in central and southern Illinois. These relations will probably hold true in other fruit-growing States, but difference in latitude, altitude, and conditions as to moisture may modify them. Should this be the case, it will be easy to ascertain the relations which apply to localities in which these modifying conditions prevail.

The advantages to be derived from the use of a table showing the relations of effective day-degree accumulations to the seasonal history of the insects are apparent. Temperature records are much more easily kept than records of the progress of the seasonal history of the codling moth based upon field observations and the former are more accurate than the latter. A spray program based upon the above table can be made out and the dates when the sprays should be applied anticipated a week or more in advance. By the use of temperature records the normal daily accumulations and the total accumulations for every day of the season may be ascertained for any locality and from these data the dates when the first individuals of each brood may be expected to appear under normal conditions may be known for that locality.

Spray programs based on fixed dates or on the time of the fall of the petals do not take into account seasonal variations and variations due to local peculiarities, to altitude, to latitude, or to other circumstances which may affect temperature.

The following program is suggested based upon the relation of accumulated effective day-degrees and the time of the appearance of the first larvae of each generation. The program provides for seven sprays, three for the first brood, two for the second, and two for the third. This program is suggested with the hope that it will be thoroughly tested and freely criticised.

TABLE 6.—SPRAY PROGRAM FOR THE CODLING MOTH

Spray	Brood of Larvae	Daily Effective Day Degrees	Accumulation of Effective Day-degrees at which spraying should begin to be completed in: 0 da.	1 day	2 da.	3 da.	4 da.	5 da.	6 da.	7 da.	8 da.	9 da.	10 da.
[1]1st													
2d	1st	16	550	534	518	502	486	470	454	438	422	406	390
3d	1st	20	790	770	750	730	710	690	670	650	630	610	590
4th	2d	26	1550	1524	1498	1472	1446	1420	1394	1368	1342	1316	1290
5th	2d	27	2050	2023	1996	1969	1942	1915	1888	1861	1834	1807	1780
6th	3d	27	2550	2523	2496	2469	2442	2415	2388	2361	2334	2307	2280
7th	3d	23	3050	3027	3004	2981	2958	2935	2912	2889	2866	2843	2810

[1]The application of the first spray for the codling moth should begin when the petals are about two-thirds off. The time of full bloom is not dependent upon effective day-degrees as defined in the preceding pages and hence the time of the application of the first spray cannot be determined by the accumulation of effective day-degrees.

MR. T. H. PARKS: I would like to know how Mr. Glenn arrived at the conclusion that humidity and evaporation are negligible factors in determining these results? With some other insects, we feel that these factors are even greater than temperature.

MR. P. A. GLENN: The remark did not apply to the Hessian fly or some other insects, but merely to the codling moth.

MR. T. H. PARKS: How do you arrive at that conclusion?

MR. P. A. GLENN: It would take 15 minutes or more to explain that. Humidity does have an effect if you use extreme humidity, but we don't get extreme humidities over a long period of time under field conditions.

MR. W. C. O'KANE: May I ask Mr. Glenn if, in speaking of day degrees, you get at it by the average temperature for the day?

Mr. P. A. GLENN: Yes. Above 50 or any degree we want.

MR. W. C. O'KANE: Suppose there were ten hours in a day and in getting at the average you had a comparatively low temperature at the beginning of the day, and then a long period of an optimum, and then drop to a low temperature, as one example; while in another day you had a comparatively high temperature and such a total as would still give you the same average; could you disregard the hourly temperatures during the day?

MR. P. A. GLENN: Yes, My method in making the average was from a continuous record of the temperatures. I added the temperatures for each hour and divided by twenty-four to get the average for the day.

MR. F. C. BISHOPP: I was very much interested in this practical application of these laws of temperature, and I believe it is possible to utilize them to a large extent in our economic procedure; but it seems to me there is necessity for continued work over a good many years in order to eliminate the various factors which creep in to interfere with our theoretical laws or rules.

In that connection I would like to ask Professor Glenn something of the duration of his investigations. How long did they cover?

MR. P. A. GLENN: Three years.

MR. F. C. BISHOPP: As I believe you brought out, in the egg stage for instance, reckoning the day as a unit, there is considerable error when only a portion of a day is utilized in the transformation.

MR. P. A. GLENN: It is only by average of a large number that we arrive at something near the correct results. If we take the day as the unit, the actual length of the period may be nearly a day longer or shorter than the observed time.

PRESIDENT GEORGE A. DEAN: The next paper is by Mr. Peterson.

FURTHER OBSERVATIONS ON THE USE OF PARADICHLORO-BENZENE FOR THE CONTROL OF THE PEACH TREE BORER

By ALVAH PETERSON, New Brunswick, N. J.

(Withdrawn for publication in a bulletin)

MR. GLENN W. HERRICK: Does it make any difference in the application between the northern and southern half of the State?

MR. ALVAH PETERSON: September 15 for the northern half, and October 1st for the southern half. Due to the fact that you never find females after September 1st in the northern half, and in the southern part after September 15th to 20th.

PRESIDENT GEORGE A. DEAN: The next is a joint paper by E. R. Sasscer and C. A. Weigel.

FUMIGATION WITH HYDROCYANIC-ACID GAS IN GREEN-HOUSES ON A COMMERCIAL BASIS

By E. R. SASSCER and C. A WEIGEL

Although the use of Hydrocyanic-Acid Gas in greenhouses for the purpose of controlling insect enemies is frequently referred to in entomological literature, as well as in florist trade papers, there are very few instances where an accurate account of fumigation on a commercial scale has been made. For the most part, these articles are of a general nature, and the authors quite frequently fail to take into consideration the effect that such factors as heat, moisture, light, exposure, quality of the chemicals, and formulae employed would have on the final results. Many valuable plants have undoubtedly been injured on account of inaccurate fumigation, and doubtless, it is on this account that we find many florists prejudiced against the use of Hydrocyanic-Acid Gas under glass.

The work which has been carried on by the authors for the past eleven years indicates that under proper conditions, Hydrocyanic-Acid Gas is very effective in controlling the more important greenhouse insects without appreciable injury to the infested plants.

It is recognized that plants vary in their susceptibility to injury by Hydrocyanic-Acid Gas, a problem which is increased in a house containing a miscellaneous collection. Incidentally, plants in certain stages of development bear considerable succulent growth which is sure to be injured if the gas is used in sufficient concentration to kill

TABLE I. RESULTS OF FUMIGATION OF COMMERCIAL GREENHOUSES

Plants	Insects	Ozs. NaCN per 1000 cu. ft.	Contents of House cu. ft.	Exposure Hours	Temperature °F. Inside House	Temperature °F. Outside House	Relative Humidity Pct.	Results
Ageratum	*Trialeurodes vaporariorum* Westw.	⅛	27,415	1	43.8	25	—	Excellent kill of adults. No burning of plants.
"	" " "	⅛	27,415	1	50.1	25	96	
"	" " "	⅛	27,415	1	64	56	82	
"	" " "	¼	27,415	1	59	41	78	100% kill of adults. No burning of plants.
"	" " "	¼	27,415	1	—	—	—	
"	" " "	¼	27,415	1	60	58	70	
Carnation	*Thrips tabaci* Lind.	½	150,000	1–½	70.3	—	98	Fully 95% of exposed thrips killed in each experiment and decided stimulation in growth of plants followed. Unopened buds developed a ringing in the form of a white discoloration, which however did not affect the value of the crop.
"	" " "	1	75,000	1	59.8	54	83	
"	" " "	1	146,000	1	57.	48	85	
"	" " "	1	144,000	1	63.3	—	78	
"		½	148,000	1	60	21	65	
"	" " "	½	338,000	1	59	36	78	
Laurus nobilis	*Coccus hesperidum* Linn.	5	46,530	1	48	30	93	Results excellent in each experiment, but in order to eliminate the scale three exposures were necessary. Vigorous new growth followed fumigation.
" "	" " "	5	46,530	1	53.4	40	87	
" "	" " "	5	46,530	1	52.5	35	84	
Miscellaneous (68 genera represented)	*Orthezia insignis* Doug.	⅜	42,000	1	69	—	86.5	95% of adults killed; eggs not affected. Slight tip burning on dahlias, salvias, jasminum, ligustrum, stephanandra, lantana, and ageratum.
"	" " "	⅜	42,000	1	69	70	81	
Miscellaneous (33 genera)	*Orthezia insignis* Doug.	½	17,000	1	64	—	97	85% kill—all stages: slight tip burning–Amaryllis. Severe burning—Pilea. 98% kill. Slight tip burning on Bouvardia, Pennisetum and avocado.
"	" " "	¾	17,000	1	71.5	70	72	

Miscellaneous (Tropical—15 genera)	*Saissetia oleae* Bern.	1–½	18,000	1	69	—	88	100% kill: no eggs hatched. Slight burning of tender foliage of Cestrum, Malvaviscus, Salix, Ligustrum and Forsythia.
Orchids	*Euthrips orchidii* Moult.	½	5,307	1	69.8	—	93	
"	" " "	½	5,121	1	73.1	—	94	
"	" " "	½	5,307	1	68.5	68	78	100% kill of exposed nymphs and adults. Very slight burning of Coelogyne, Dendrobium, and Cattleya. Injury negligible. Of the 473 plants treated many were in full bloom.
"	" " "	½	5,121	1	72.1	66	73	
"	" " "	½	5,307	1	64.8	—	66	
"	" " "	½	5,121	1	68.6	—	78	
"	" " "	½	5,307	1	69.2	56	66.5	
"	" " "	½	5,121	1	73	56	69.5	
"	" " "	½	5,307	1	71.5	64	90.5	
"	" " "	½	5,121	1	73.2	64	82	
Palms, misc.	*Ischnaspis longirostris* Sign.	2–½	37,000	1	59.1	20	72	Scale mortality excellent. Slight burning on some Kentias 10 days after exposure to gas probably due to excessive sunlight which followed the day after the last fumigation.
" "	" " "	2–½	37,000	1	61.2	22.4	73	
" "	" " "	2–½	37,000	1	68.7	35	61	
Roses—2500	*Paria canella* Fab.	2	34,612	1–¾	85	80	—	A minimum of 95% of exposed beetles killed in all experiments. Plants resting at time of fumigation. Tender growth burned. *Muslin curtains used to separate houses.
" 2500	" " "	1–½	34,612*	1¾	78	76	—	
" 3600	" " "	2	47,449	2	76	75	—	
" 3600	" " "	2	47,449	2	75	72	—	
" 3600	" " "	1–½	47,449*	1–¾	78	76	—	
" 3000	" " "	2	30,408	1–¾	75	75	—	
" 3000	" " "	2	30,408*	1–½	76	75	—	
" 3000	" " "	2	30,408*	1–¾	72	72	—	
" 3000	" " "	2	30,408*	2	73	71	—	
" 7300	" " "	2	108,536*	1–½	76	75	—	
" 7300	" " "	2	108,536*	1–¾	72	72	—	
" 2800	" " "	1–¾	33,299*	1–¾	71	70	—	
" 6400	" " "	2	79,488*	2	84	83	—	
" 4100	" " "	2	59,823*	2	66	62	—	
Roses	*Paria canella* Fab.	2	146,315	2	—	—	—	Results on insects same as above. Resting period over and abundance of new growth present which was burned back to hard wood. Injury completely outgrown within five weeks.
"	" " "	2	78,412	2	76.9	—	91	
"(American Beauty)	" " "	1–½	114,061	2	75.3	—	92	

insects; as for example, roses can be safely fumigated during the resting period at the rate of 2 ounces of Sodium Cyanid per 1000 cubic feet of space, whereas, in the forcing period ½ ounce may cause serious injury under unfavorable conditions. In commercial fumigation, therefore, these conditions must be borne in mind, it being understood that a house should not be fumigated until the maximum dosage for the plants involved has been determined.

The experiments summarized below were conducted after preliminary tests had been made to determine the necessary dosage to kill the insects, and at the same time not injure the plants.

Conclusion

The results contained in the above table indicate that:

1. The common greenhouse insects can be controlled by persistently using weak dosages.
2. These dosages, under the proper conditions, will not reduce the market value of the plants.
3. Greenhouse plants for the most part show decided stimulation, resulting ultimately in a greater financial return.
4. Large houses may be satisfactorily separated by the use of canvas or muslin curtains, thus obviating a serious problem of the past in open range houses.
5. It is evident from the results thus far obtained that some plants may be fumigated while in bloom without injury to the flowers; for example, carnations and orchids.

Aside from the above facts, the cheapness of fumigation as contrasted with the cost of spraying is an additional argument in favor of this method of controlling insects in commercial greenhouses.

Formula Employed:

For each ounce avoirdupois of Sodium Cyanid (containing approximately 51% cyanogen), 1½ liquid ounces of Sulphuric Acid (1.83 specific gravity) and 3 liquid ounces of water were used. This is a slight divergence from the formula which has been generally accepted owing to the necessity of securing sufficient dilute acid to submerge the cyanid. Under greenhouse conditions, it is necessary to use a number of generators in order to secure an equal distribution of the gas, and as this number is increased, the amount of chemicals in each generator is proportionately decreased, which will result in poor generation unless there is a slight excess of water. If it were possible to have a number of small generators considerably constricted at the bottom it would be possible to get a satisfactory generation with the 1-1½-2 formula.

Mr. R. L. Webster: I would like to ask Mr. Sasscer what conditions he thinks are favorable to fumigation injury?

Mr. E. R. Sasscer: There are a number of factors which may cause injury. Fumigating in the daylight, fumigating when you have a

very high temperature, fumigating on an especially cold night and allowing the plants to become chilled, when the ventilators are open to permit exit of gas. Moisture in the house will not materially affect the result except that if the walks and soil are very wet, they will absorb so much of the gas that the fumigant will not be effective against the insect.

MR. R. L. WEBSTER: In some of the work that I did in New York State, it seems that moisture—particularly inside the plant—not moisture on the outside or the moisture of the air—was conducive to injury. It seems that the gas enters a plant in the same way that carbon dioxide does; through the stomates. It gets into the intercellular spaces, and then if there is a good deal of moisture it penetrates readily into the cells, causing injury. A good deal of this is theoretical but it seems to work out pretty well. It is largely a question of moisture in the cell walls of the plants.

PRESIDENT GEORGE A. DEAN: The next paper is by C. A. Weigel and Charles F. Doucette.

FURTHER OBSERVATIONS ON THE STRAWBERRY ROOT WORM[1] ON ROSES

By C. A. WEIGEL and C. F. DOUCETTE

In a preliminary report[2] given in an earlier number of this Journal the seriousness of this insect as a menace to greenhouse roses was discussed. Since then a careful survey has given evidence that this insect is now of prime importance to rose growers in practically all of the commercial rose districts of the United States, and in several establishments the plants have been almost totally ruined for commercial purposes. An active investigation of the life history and control measures was inaugurated by the Bureau of Entomology in 1919, and since February 1920 conducted as a joint project in cooperation with Prof. J. G. Sanders, Director Bureau of Plant Industry, Pennsylvania, with laboratory headquarters at Doylestown, Pa. The preliminary life history studies which were started by Messrs. Weigel and Chambers were subsequently taken up by the writers, assisted at intervals by Messrs. Primm and Buckman of the Pennsylvania Bureau of Plant Industry.

LIFE HISTORY AND HABITS

THE EGG: In the life history studies it was found that the eggs were deposited in the curled-up, dead and dried leaves, singly or in masses

[1] *Paria canella* Fab.
[2] Jour. Econ. Ent. v. 13, pp. 226-232.

up to 15, averaging about four per mass, and records show that a female may lay as many as 216 eggs during its life. The period of incubation varies from a minimum of seven (7) days to a maximum of twenty-seven (27) days. When first laid the eggs are white in color, later becoming yellow, and each egg mass is surrounded almost invariably by a heavy cement-like secretion. The egg is about 1 mm. in length and elongate oval in shape. While egg-laying is continuous throughout the first eight months of the year, there are two periods when egg deposition is particularly marked, viz., in March and April and in June and July.

THE LARVA: The newly hatched larvae, which are very active, enter the soil immediately where the development of both larvae and pupae takes place. The full grown larvae are about 5 mm. long; white in color; except the head and tips of claws which are brownish; resembling white grub larvae except for size. It was found that the larvae require from sixty to seventy-four days to complete growth. In this stage considerable injury is done to the roots of the plants.

THE PUPA: When ready to pupate the larva hollows out a cell in the soil and there transforms to the pupa which emerges as an adult after eight to thirteen days.

As high as twenty-three specimens of the soil forms, i. e., larvae and pupae have been found around the roots of a single rose plant at depths varying down to four inches. The greater part of the larvae and pupae are usually located directly in the ball of roots.

THE ADULT: The average longevity of the adult has not yet been definitely determined owing to the long period of egg-laying and subsequent overlapping of broods. Adults collected in the greenhouses and kept under constant observation have lived a maximum of 141 and 156 days. Adults reared from pupae in early June lived (1) Dec. 3—160 days.—(2) Dec. 23—180 days and in that period deposited about 40 eggs. Further experiments are now in progress to determine the remaining features of the adult stage.

SEASONAL HISTORY: From the observations thus far taken it appears that the adults which emerge in September and October spend the winter hiding in mulch or soil, occasionally coming out to feed on clear sunny days. After early February they are found more frequently on the plant. Egg laying commences the latter part of February and continues through March and April with some egg-laying at all times throughout the spring months. Adults are not very numerous during the latter part of April and in May, but appear in large numbers in June and July. During the latter two months a considerable num-

ber of eggs are laid. In September and October the adults again become numerous and these adults are evidently the ones which live over the winter. After August very few eggs are laid; however, during most of the year all forms may be found in the soil. From the above it is apparent that there are at least two generations a year under greenhouse conditions.

Experiments in Control of Soil Stages

In view of the fact that the larval and pupal periods, which require from six to eight weeks, are spent in the soil, our efforts during the first season were largely directed to the finding of some soil application, either an insecticide or a fertilizer, which would operate against these stages and hence prevent the emergence of the adults. With this object in mind the following materials were tried out during the season of 1920.

a. Carbon bisulfide—5 to 25 cc injected between bushes approximately 14" apart.

b. Carbon bisulfide in solution—¼ to ½ ounce dissolved in four gallons water applied to twenty-four square feet.

c. Sodium cyanide in solution—⅛ to ½ ounce per gallon of water applied to six square feet.

d. Cyanamid—½ to 2 lbs per 40 sq ft.

e. Acid Phosphate—200 lbs to 1200 sq. ft.

f. Wood Ashes—200 lbs to 1200 sq. ft.

g. Tobacco Dust—200 lbs. to 1200 sq. ft.

h. Hydrated Lime—200 lbs to 1200 sq. ft.

The above applications were based on one plant per square foot. Applications of the last five materials were followed by thorough watering to insure prompt leaching of the active elements. Considering both plant tolerance and insecticidal value, the acid phosphate, wood ashes, and tobacco dust were the more promising.

In the season of 1921 an excellent opportunity presented itself for further experimental work along this line. At a wholesale rose establishnemt at Doylestown, Pa., a ground bed containing approximately 800 plants heavily infested with soil forms of *Paria canella* was placed at the disposal of the writers. It is interesting to note that these plants had been growing in this bed for eight years which may account for the extremely heavy infestation, where around the roots of some plants as many as twenty-three (23) individuals were found.

Preliminary tests were first conducted with potted rose plants in which a definite number of larvae and pupae from the infested bed were buried at their normal depth. The effectiveness of the following ma-

terials was tested in these pots, observations being taken either five or ten days after treatment:

Paradichlorobenzene—2 gms. to 8 gms. per plant.
Borax—1 gm. and 2 gms. in solution per plant.
Sodium cyanide—0.45 gms. to 1.77 gms. in solution per plant.
Orthodichlorobenzene—3 cc. per plant.
Mercuric chloride—(rate of ½ ounce per 3 gallons water, ½ pint per plant).
Kerosene nicotine oleate emulsion (1 part to 16 parts water; 1 part to 32 parts water per plant).
Wood ashes—handful at base of each plant.
Tobacco dust—handful at base of each plant.
Lye—one teaspoonful per plant.
Nicotine Sulfate—2 drops in 225cc water per plant.

Of these materials Paradichlorobenzene, Orthodichlorobenzene, Sodium cyanite and Kerosene Nicotine Oleate emulsion gave promising indications.

With this as a basis a total of thirty-eight plot experiments were then conducted on the infested bed using from five to twenty-five plants in each test. Examinations of the treated as well as the check plants were made at as close to five day intervals as conditions would permit by digging up the plants and examining the roots and surrounding soil for the larvae and pupae present. In this manner, observations were made on the effectiveness of the materials used as well as the minimum time which was required for them to exert their insecticidal action. The following materials were used:

Paradichlorobenzene was employed in fourteen tests in amounts ranging from five grams to one-half ounce per plant.

Sodium cyanide was tested in nine plots, using from one-half to five grams dissolved in about one pint of water and poured around the base of each plant. The same material in the dry form was applied at the rates of two, three, and five grams per plant, respectively.

Kerosene nicotine oleate emulsion in dilutions varying from one-fourth pint to one pint per gallon of water was used in five tests.

Orthodichlorobenzene was given three trials of 1cc., 2cc., 3cc., per plant respectively, applied directly at the base of the plants.

One-half ounce mercuric chloride dissolved in three gallons water, as well as tobacco dust, wood ashes, and a combination of the two, were also tested.

RESULTS: Tobacco dust and wood ashes, alone and combined gave encouraging indications but as they are now being tried out on a commercial scale further comment is reserved. Mercuric chloride proved entirely valueless. While orthodichlorobenzene trials produced a mor-

tality of 52% at the highest dosage, its further use was precluded because of the severe injury to the plant. Kerosene nicotine oleate emulsion gave varying results as far as mortality was concerned, but owing to the greasy and objectionable condition in which the soil is left after application, this material is ruled out. Sodium cyanide in the dry form is also removed from consideration because in all the tests the plants were killed in a very short time after application. Sodium cyanide in solution gave appreciable killing (77%) but as with the dry material its severe injury to the plant caused it to be eliminated. In the trials of paradichlorobenzene excellent killing of both larvae and pupae resulted, but in practical tests it was found that the rose plants do not tolerate this substance.

In summing up these soil experiments it is seen that most materials gave negative results, either because of the plant intolerance or the ineffectiveness against the insect. It is thought that further tests of the tobacco dust and wood ashes may form a basis for the successful control of the soil stages.

Experiments in Control of Adults

Spraying: In the preliminary account[1] it was pointed out that under the usual growing conditions the use of arsenicals sprayed on the rose plants has been found to be impractical, ineffective, and objectionable. It is impractical because the forcing of the plants causes considerable new growth to push forth overnight which necessitates constant and almost daily spraying to keep all of the foliage covered with the poison; it is ineffective because it was found that the beetles avoided the sprayed portions in their feeding; and objectionable because of the whitish deposit left on the foliage.

There is, however, one phase in the culture of roses when the use of an arsenical as a spray has been proven to be effective. When the rose plants are "cut back" practically all the foliage is removed and the fresh growth develops from new buds. The absence of foliage forces the beetles to feed on the green bark as well as the swelling and breaking "eyes" or buds, causing serious retardation of the growth. By spraying the stems and swelling buds with 4 to 5 pounds powdered arsenate of lead, or calcium arsenate, to 05 gallons of water, the plants in several infested rose houses passed this critical stage during the past summer with almost no injury by the beetles.

Dusting: Experiments with powdered arsenate of lead, one part mixed with nine parts of superfine sulfur, have been carried on during

[1] *Loc. cit.*

the past two seasons as a substitute for spraying with a certain degree of success. No objectionable deposit is left on the foliage of the cut flowers because of the frequent syringing, but the ease and rapidity of application makes it possible to keep the leaves continually dusted. Besides, the fungicidal value of the sulfur for the control of leaf-spot and mildew should not be overlooked. The final conclusions on the effectiveness of the dust treatments will probably be reached during the coming season.

Hydrocyanic Acid Gas

The use of hydrocyanic acid gas as a fumigant has been mentioned[2] as a control measure for the adult stage. Since then the successful use of this gas has been demonstrated on a practical and commercial scale. During the past season a total of approximately 32,000 rose plants were fumigated during the resting or "drying-off" period with a dosage of two ounces sodium cyanide per 1000 cu ft. of space, with an exposure of two hours and at temperatures ranging from 66° to 88° F. In some cases the houses received three or four successive fumigations. In these tests it was demonstrated that muslin curtains could be used successfully to confine the gas in any section of an open range of houses. The anticipated burning of the tender growth is a negligible factor because any such injury would be removed in the severe pruning which was mentioned previously. Of the 32,000 plants including 1000 newly set young plants, not one was lost or retarded in growth because of the fumigation.

President Arthur Gibson takes the chair.

President Arthur Gibson: This constitutes the fifty-eight annual meeting of the Entomological Society of Ontario, and this organization is very glad to meet with the American Association of Economic Entomologists today. We appreciate the fact very much that you came to Canada and are holding your meeting in Toronto this year.

The first paper is by Mr. W. C. O'Kane.

ONE YEAR OF THE CROP PROTECTION INSTITUTE

By W. C. O'Kane, *Chairman of the Board of Governors*

One year ago at this time, members of this Association were asked to give their support to a newly organized movement, the Crop Protection Institute. A similar request was made of the men in Plant

[2]*Loc. cit.*

Pathology and in Agricultural Chemistry. This paper is in the nature of a brief statement of the progress of this movement during the past twelve months and what appear to be its prospects.

Shortly after the Association met at Chicago a year ago, the first regular meeting of the Crop Protection Institute was held at Rochester, N. Y. At that time a modification of the control of the Institute was worked out, was submitted to all the members and was adopted. The management of the Institute, therefore, is now in the hands of a Board of Governors, made up exclusively of scientific men, three of whom are chosen by the American Association of Economic Entomologists, three by the American Phytopathological Society, two by the Association of Official Agricultural Chemists and one by the National Research Council, making nine members in all. This Board is responsible for the direction of the Institute.

In addition, provision has been made for the setting up of Boards of Trustees of three members for any industrial division that may be created within the Institute. Such a Board is responsible for the finances of its own division and sits in conference with the Board of Governors in consideration of matters relating to its division.

The first accomplishment of general interest carried through by the Institute was a conference on control of the cotton boll weevil by dusting. This conference was held in New York and was attended by scientists representing the Bureau of Entomology and by a number of manufacturers producing poison dusts and dusting machinery. The purpose was to standardize recommendations and to correct errors. The situation was discussed frankly and fully. Following the conference a concise statement of rules relating to dusting for boll weevil was prepared by experts of the Bureau and was placed by the Institute in the hands of manufacturers to be transmitted by them to their salesmen, agents and retailers.

At a meeting of the Board of Governors in January preliminary plans were drawn up for a cooperative dusting project, to be carried out under the direction and with the assistance of the Institute, the actual experimental work to be in charge of the entomologists and plant pathologists in the several states taking part in the project. This plan was carried through successfully and with interesting results. The necessary materials were provided by manufacturers. The experiments in the several states were carried out on parallel lines. The investigation was conducted jointly in New York state, Pennsylvania and West Virginia. A director of the project, selected by the Board, visited the various plots, and at the close of the season there was a meeting to examine data.

The results constitute a genuine contribution to scientific knowledge and will be published soon as a bulletin of the Crop Protection Institute. The project demonstrated the feasibility of looking to the institute as at least one available means to bring about profitable and desirable cooperation among investigators. The project was not an expensive piece of work. It utilized, as it should, the existing, well-equipped, and well-qualified agencies in the shape of scientific workers and laboratory equipment in the several states concerned. It simply brought these together in a mutually helpful relationship. There appears to be no reason why the Institute cannot serve as a means of furthering other broadly conceived and timely investigations.

During the year the Institute has been engaged in preliminary work on a project relating to the Ox Warbles. It is well-known to entomologists that the two species of Ox Warble that we have in this country, *Hypoderma lineata* and *Hypoderma bovis*, cause enormous losses each year to farmers and stock growers, to the packing houses that must sell grubby hides, to the tanners who must buy such hides and, eventually, to the public, who must pay an additional price for sound leather. It has long been known that, technically speaking, it should be possible to reduce damage by the Ox Warbles, at least in certain localities, for the reason that the species is in position where it can be got at beneath the hides of cattle at a certain period of each year. Cattle represent a definite quantity to which access may be had. Researches by Bishopp have disclosed a simple and not too expensive ointment that may be applied with excellent results.

The Board of Governors decided to endorse an attempt to carry out a program of control and elimination in a typical, stock-raising county in the east, in which both species of warbles are present and are destructive in marked degree. The Institute sought the assistance of the Tanners' Council, an organization representing the large tanning interests of this country, and was successful in securing from them an appropriation of $9,000, extending over a period of three years, this appropriation being contingent on the securing of other necessary funds from other sources. Approaches were made to the authorities of several counties in New York state with encouraging reception. Support was sought, also, from the Institute of the American Meat Packers, but in the recent conditions in the business world this source did not materialize. Other avenues are now being approached.

It is planned to carry out, if possible, some necessary preliminary work this present winter and it is expected that the project will, even-

tually, be carried through. The plan calls for a three-year program, involving from 40,000 to 60,000 head of cattle and under the scientific direction of experts from the Bureau of Entomology.

The Institute has undertaken to establish contacts with several other industrial groups whose interests are related to the work of the entomologist and plant pathologist. The purpose of this is to pave the way for research in these industries.

A committee of the Institute is now at work on the details of a fourfold project relating to sulphur. The four aspects of this project include: first, the action of sulphur as an insecticide, both as elemental sulphur and in its compounds; second, its action as a fungicide; third, the effects of meteorological conditions on the action of sulphur; and, fourth, sulphur in relation to soil. The committee has been in conference with two of the large producers of sulphur and has found that they are interested. The Institute expects to present a detailed plan and a budget to these producers soon.

Other industrial groups with whom conferences have been held include the following:

(1) The Cereal Division of the American Specialty Mfrs. Association, which includes manufacturers of package cereals in this country. This group is footing a bill for large losses due to insects attacking stored products. Their problem is complicated by the fact that warehouses in which package goods are stored become infested, as do the establishments of wholesale grocers, and, therefore, goods that leave the manufacturers free of insects may reach the consumers badly infested.

(2) The American Tobacco Company, in which heavy losses are resulting from the work of tobacco-infesting insects.

(3) The American Seed Trade Association. There are two problems here, one concerning losses due to insects infesting stored seeds; and, second, a problem relating to the role of seeds as carriers of pathogenic organisms. A member of the Institue has been invited to appear before the next convention of seedsmen and to present a paper explaining the second problem alluded to above.

(4) The National Lime Association. Fundamental questions are involved here, relating to the action of lime, both alone and in compounds, in relation to both insects and plant diseases. A committee representing the Institute will present soon a plan for an investigational project and a proposed budget for the same.

(5) Oil refiners. The Institute has had a preliminary discussion with one of the large oil refiners as to possible chemico-biological stud-

ies in various petroleum derivatives. It appears that a working arrangement that would utilize the laboratories and knowledge of the oil chemist with the facilities and the knowledge of the entomologist, would promise interesting results.

From time to time during the year the Board of Governors of the Institute have considered various aspects of a proposed plan by which the Institute would establish a procedure for scientific testing of insecticides and fungicides. A plan to this effect has been drawn up in tentative shape by a special committee. The committee has sought the counsel of the Federal Insecticide and Fungicide Board, with the intent that the plan if adopted shall represent a harmonious connection with the federal authorities. In general, the proposed procedure would provide that a manufacturer of insecticides or fungicides, or a producer of basic materials, can come to the Institute for a scientific study of a product, the expense of this study to be provided by the manufacturer, the funds to be administered by the Institute. It is proposed that the Board of Governors would arrange with experts among the scientific members to carry out such tests or investigation and would make proper financial arrangement therefore. The reports of the investigators would be made to the Institute. Publication of results may or may not be undertaken, according to the circumstances of the case. The intent of this procedure, if it is adopted, will be to provide an authoritative and competent agency to which the manufacturer can turn for a proper scientific study of his product and, at the same time, to discourage ill-founded or misleading claims or statements by manufacturers.

In summing up, the Institute has received cordial support from the scientific workers, including active, though unofficial cooperation from members of the Bureau of Entomology and Bureau of Plant Industry; although the latter have not yet been granted specific permission to become members. There are now, approximately, 250 scientific members of the Institue, 25 industrial members and 25 associate industrial.

The accomplishments of the first year have not been as much as might be hoped. But it is believed that a start has been made in activities that are substantial and will prove worth while.

PRESIDENT ARTHUR GIBSON: The next paper is by E. H. Strickland.

POISONED MOLASSES FOR THE DESTRUCTION OF NOCTUID MOTHS

By E. H. STRICKLAND, *Entomological Branch, Ottawa, Can.*

The annual loss on the western prairies from the destruction of grain crops by the Pale Western Cutworm (*Porosagrotis orthogonia* Morr.) has amounted in recent years to several millions of dollars. Numerous experiments, conducted in the infested provinces and states, have failed to produce an effective method of controlling this pest in its larval stage. For this reason the problem of destroying the adults before they have reproduced has received considerable attention.

Three methods have presented themselves to us as a possible means of gaining this end, namely, light-traps, molasses troughs and poisoned molasses. In experimenting with these we have aimed at producing a method that will have the following qualifications; all materials used are readily procurable in any farming community, very frequent attention to traps is unnecessary, and it is inexpensive to operate. The employment of poisoned molasses approaches more closely to the fulfilment of these conditions than does either of the other methods.

LIGHT-TRAPS

In 1913, we placed a few light-traps in fields around Lethbridge, where an outbreak of *P. orthogonia* had been somewhat severe. The nightly catch never exceeded fifty-eight moths of this species and of the total captures 97.5% were males. For this reason we considered the method to be economically ineffective. In 1920, Circular 94 of the Montana Experiment Station recorded a night's capture of as many as 1,500 moths of this species in individual light-traps which were of a superior type to that which we had used in 1913. This year Mr. H. L. Seamans, who has recently come from the Montana Station to take charge of the Dominion Entomological Laboratory at Lethbridge, constructed a number of traps similar to those in which these large captures were made. Two of these were set out in a badly infested field at Lethbridge and about six were operated by our assistant, Mr. W. Carter, with the help of some farmers in the very heavily infested district around Retlaw, which is about sixty miles to the north-east of Lethbridge. These traps were set out from the middle of July till September 8th, when snow and frost put an end to the flight of *P. orthogonia*. During periods of moonlight, high wind and other unfavourable weather these traps were not operated. The results were

disappointing. The largest capture of *P. orthogonia* at Lethbridge was 517 ♂♂ and 17 ♀♀, the average per "trap-night" being 84.3 ♂♂ and 2.03 ♀♀. The Retlaw traps captured 41.3 ♂♂ and 3. ♀♀ per "trap-night." Of the total capture of 34,500 speciments of *P. orthogonia* which were taken in the field by light-traps 94.97% were males. This percentage was very little better than that obtained in 1913.

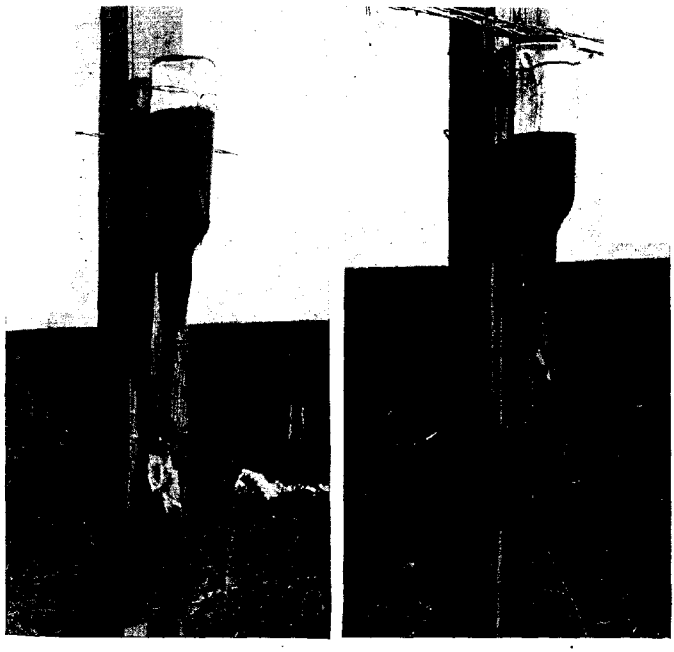

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FIG. 6.—THE ALBERTA MOTH TRAP

1. Trap so arranged that the majority of moths will be retained.
2. The most suitable type of trap for moth destruction.

We do not know to what extend the males are monogamous in nature, but it would appear that on this factor alone depends any appreciable benefit to be derived from light-traps.

We consider light-traps to be unsatisfactory as a general method of control on the prairies for the following reasons:

1. They require attention twice daily.
2. They are somewhat expensive to operate.
3. They are practically ineffective during periods of full moon.
4. They are not well adapted to a windy country.
5. For the species under consideration they catch too small a percentage of females.

Molasses Troughs

This method was suggested by the experiments conducted by Dobrovljansky[1] for the control of *E. segetum* in Russia. Early in September 1920, three galvanized iron troughs, 2 feet long and 6 inches wide and deep, were set out in a badly infested area. Each was half filled with a 66% solution of molasses in water. On the first night they captured a total of 382 moths of which 135 were females of *P. orthogonia*. A slight crust had formed on the surface of the molasses by the following night when 16 moths only were retained. Of these 8 were females. It was obvious that we might be attracting to the field moths that we were unable to capture and that possibly our troughs were doing more harm than good to the owner.

Attempts to improve the consistency of the molasses solution failed to give satisfactory results. In a 50% solution many moths swam to the sides and escaped while any stronger solution crusted over in a very short time. Some twenty troughs were used in 1921, and attempts were made to retain the moths in weak solutions by the addition of vegetable and other oils, with tanglefoot and with poisons, but without success.

This method was early abandoned for the following reasons:

1. The troughs require very frequent attention.
2. A great many of the moths escape.

Poisoned Molasses

P. orthogonia comes very readily to "sugar" applied to fence posts. A fence post can be kept permanently "sugared" every evening for from ten to fourteen days by means of a simple apparatus. The only material required is a quart bottle with a cork to fit, 6 inches of lamp wick and a small piece of absorbent cloth. The bottle is filled with the sugaring mixture and the end of the wick, which has first been well saturated in the mixture, is inserted. A well fitting cork, that has been slightly flattened on one side by cutting away a small portion with a knife is pressed fairly tightly into the bottle with the flattened side next to the wick. The bottle is then inverted and wired or tied to the west side

[1]Extract in Rev. Applied Ent., Series A. Vol. 1, p. 490, 1913.

of a fence post, and the free end of the wick is nailed to the post through a piece of absorbent cloth. When a rapidly killing poison is used, and it is desired that material obtained be preserved, a partial funnel of mosquito netting or paper can be attached to the post as is shown in figure 6, 1. A modification, suggested by Mr. Carter, is to replace the cloth with a shallow pan made from a tomato can (Figure 6, 2). This forms a reservoir for any surplus flow of poison.

The bottle is fastened to the west side of the fence post in order that it will not be exposed to the direct rays of the sun till the afternoon. The heat then causes its contents to expand and to drive some of the liquid down the wick and on to the cloth. This action usually continues till nearly sunset and it liberates sufficient bait to attract moths throughout the night. After the sun has set a reverse pressure in the bottle draws in sufficient air to replace the expelled liquid.

Provided the variations in temperature are not too extreme, or fermentation too rapid, a quart bottle will run every evening for from ten to fourteen days. We have tried several modifications of reservoir and methods of controlling the flow of bait, such as the "drinking-fountain", siphon, and gravity feed, but find the inverted bottle to be as satisfactory as any.

Having obtained a satisfactory apparatus, our next concern was to find a suitable poisoned bait. As a basis a 10% solution of cane molasses was used in all cases. This ferments within a few days of mixing. In the fall of 1920, experiments were made in which the decantation from a saturated solution of white arsenic was used as the diluent. This killed moths in the laboratory in from 8 to 40 hours, but was found to be somewhat deterent to feeding.

When this solution was used in bottle traps moths fed on it and obtained sufficient poison to cause their death within 24 hours. This was proved by captured specimens. In the field, however, they all flew from the traps before dying. It was hoped that some immediate killer could be obtained in order that we might estimate the value of the traps, and be certain that gravid females were unable to deposit their eggs before dying. It was also highly desirable that those who might be using the traps as a practical means of control should be able to see some results from their efforts in the form of dead moths.

To this end we planned a series of experiments in 1921, but it was not until nearly the end of the season that Mr. Seamans found quassia to be the nearest approach to what we desired. Subsequent observations showed that this material must be used in conjunction with some other poison.

Among substances employed with the hope of obtaining an immediate killer were various arsenicals, soluble strychnine, copper sulphate, formalin, mercuric chloride, sodium cyanide in solution, and sodium fluoride. *All of these failed to kill in less than about 12 hours except in strengths* that proved to be deterrent. Arsenical poisons showed the least deterrent effect in the field when they were employed in weak solutions. Various objections to most of the forms of arsenic that are readily available to a farming community decided us to adopt commercial fly pads, at the rate of one pad per quart of solution, as the most satisfactory source of supply. At this strength the arsenic is very slightly deterrent and there is no precipitation. The pads can either be soaked in the solution over-night or be cut into strips which are inserted into the bottles. Moths captured while feeding on bottles so poisoned died in from six to one hundred hours, depending upon the amount of feeding prior to capture. The majority of poisoned moths died within 36 hours. Checks taken from unpoisoned bottles lived for an average of 130 hours without subsequent feeding.

The season was unfavourable for bait traps. A very dry summer had resulted in the failure of many crops and had seriously hampered summer-fallowing, with the result that nearly all classes of fields were covered with Russian thistle. This was flowering at the time of flight. Noctuidae feed freely on these flowers, but the favourite food plant in Alberta appears to be golden-rod, which flourishes in restricted areas of waste land. Experiments with traps placed in these golden-rod areas showed that fermenting molasses, when used alone, was not sufficiently attractive to overcome the predilection of the moths for these flowers. With the addition of eight drops of amyl acetate per quart of the solution, both sexes of *P. orthogonia* could be attracted to feed on the bait despite the close proximity of a strong counter attractant.

The abundance of feeding is very variable and we did not obtain very definite data upon the probable catches made by our experimental traps. At night there were frequently as many as 20 to 30 moths, of which over 50% were female, feeding on a single trap at a time when very few were attracted to troughs of molasses. By day males were found feeding at all hours, though they were most abundant between the hours of 2 and 5 P. M. Females appeared less frequently in the morning and were seldom seen in numbers till about 4 P. M., by which time they visited the traps freely and were nearly as numerous as the males on golden-rod blossom.

We did not discover that quassia would retain the majority of moths that visited a trap till too late in the season for this to supply us with many data.

In the laboratory, however, and with a few bottle traps, we found that the deterrent effect of quassia is very slight and that it is readily overcome by the addition of a little saccharine to the bait.

The effect of quassia on moths is very variable and it cannot be predicted for the individual. Moths captured feeding on flowers, were offered a choice of formulae. Those containing quassia and saccharine were preferred to straight molasses. This was also demonstrated in the field. At a strength of two ounces to a quart of solution quassia kills about 65% of all moths that feed on it. In some cases death is rapid, and within ten minutes of feeding either sex of *P. orthogonia* loses all power of locomotion, lies on its back and response to stimulation becomes continually less apparent till it ceases entirely. Death in such cases appears to be gradual and progressive. In other cases moths feed freely on the bait for a few minutes and suddenly flop around the receptacle as though in great pain, till sudden death puts and end to their activity.

On the other hand some 35% of the moths which have imbibed quassia solution, sometimes more extensively than have those which die, become either very sluggish or quite inactive a few minutes after feeding and they may remain in this condition for two or three days. Sometimes females, which have been quite inactive for over 24 hours, will laboriously struggle to their feet, lay a few eggs, and relapse into inactivity. Recovery in other cases appears to be complete, and since it permits oviposition, we have retained the use of fly pads in addition to quassia. Our experiments indicate that very few moths will recover from the effects of the latter before they succumb to the arsenical poison of the former.

At present our poisoned bait formula, therefore, consists of:—a 10% solution of cane molasses, the diluent being water in which quassia chips have been soaked overnight at the rate of two ounces to the quart. In each bottle of this solution is inserted one fly pad, sufficient saccharine to cover a Canadian 5 cent piece (1 gram), and eight drops of amyl acetate.

This formula undoubtedly can be improved considerably both as regards its attractiveness and poisoning ability. As it stands, all of the materials, with the exception of amyl acetate which is not essential, can be obtained in any village.

The present retail cost of materials for a dozen traps, including the bottles, is approximately $2.65.

We have no definite data as to what distribution of traps will give the greatest returns for money expended, but believe that one to every

ten rods of fencing around a field that is free from flowering weeds should be sufficient to reduce an outbreak very materially. On weedy fields subsidiary posts erected in the field might be necessary.

Poisoned molasses traps give more promise for controlling noctuid moths than do other methods tried because:—

1. They require attention, at the most, once a week.
2. Females are attracted as readily as males to bait and they are usually gravid.
3. With a combination of quassia and arsenic very few females that feed on the bait are able to lay eggs subsequently.
4. Quassia is non-poisonous to stock and is distasteful to them.
5. Individual traps attract more moths than do corresponding troughs of molasses.
6. All materials are cheap and are readily obtainable anywhere.
7. The bait is effective by day as well as by night and its efficacy is not reduced by moon light.
8. Climatic conditions affect the traps very little.

MR. GLENN W. HERRICK: What quantity of moths did these bottles kill?

MR. E. H. STRICKLAND: Unfortunately we had a snow storm before our investigation was finished, but we found that we were getting thirty to thirty-five of the females feeding at the same time at each of the bottles, and we occasionally found sixty or seventy moths feeding when only six or seven were attracted to each molasses trough. Since these bottles are much cheaper than the troughs, we found them superior in every respect. This is, however, very preliminary work.

MR. L. CAESER: I would like to ask whether they are assuming that the moths lay their eggs after taking the arsenic or if there is definite proof of it?

MR. E. H. STRICKLAND: We have definite proof that they do. We also, unfortunately, have data to prove that they may lay eggs before they take any food at all.

MR. WILLIAM MOORE: It might be of interest to know that before Prof. Berlese developed his sweetened arsenical for the fruit-fly, there is reference in Australian literature to sweetened material as a house-fly poison.

PRESIDENT ARTHUR GIBSON: Mr. Criddle will now present his paper.

THE WESTERN WHEAT STEM SAWFLY IN CANADA

By NORMAN CRIDDLE, *Treesbank, Man.*

(Withdrawn for publication in the 52d Report of the Entomological Society of Ontario.)

MR. R. L. WEBSTER: I have been greatly interested in Mr. Criddle's paper, because this, like other insects, has absolutely no regard for international boundaries. It caused a great deal of damage in North Dakota in 1921.

I would like to ask Mr. Criddle if it is possible that the same number of insects might be present per square mile over the whole area and yet the damage show entirely in the dry area?

MR. NORMAN CRIDDLE: That is the point I wish to make. The sawfly is all over the area, but it does not develop where there is a vigorous growth, and that, of course, is brought about by rainfall.

PRESIDENT ARTHUR GIBSON: The next paper is by H. A. Gossard.

PROGRESS IN HESSIAN FLY CONTROL

By H. A. GOSSARD, *Wooster, Ohio*

(Withdrawn for publication elsewhere)

MR. F. Z. HARTZELL: I would like to ask the difference between the peak of emergence and the date of plowing? Would it be safe to plow when emergence had been reached, or to wait?

MR. H. A. GOSSARD: That would depend on the density of the brood. In 1920, the brood was so dense that we felt perfectly justified in holding everybody back until the peak was passed and on the decline, because we were sure that the tail end of the brood was so heavy that if this method was not followed, we were likely to have very heavy infestation.

In 1921, the brood was not so heavy and we were not afraid of the tail end of the brood. In other words, the tail end of the brood was not going to be heavier than the normal brood. They laid their eggs a little later than we expected, but we were making observations and did not feel the need for calling for a later seeding. We allowed the farmers to go ahead and seed at the time already agreed upon, and it turned out satisfactorily. If we had had a heavy brood, we would have asked them to wait until the peak was diminishing.

PRESIDENT ARTHUR GIBSON: The next paper by Messrs. Crawford and Spencer is one of a series.

THE EUROPEAN CORN BORER (*Pyrausta nubilalis* Hubn.): LIFE HISTORY IN ONTARIO[1]

By H. G. CRAWFORD, *Entomological Branch, Ottawa,* and G. J. SPENCER, *Ontario Agricultural College, Guelph, Ont.*

The apology for presenting so incomplete a study rests upon the fact that this is a recently introduced and already widely distributed insect, spreading with great rapidity, and capable of doing very serious damage. Consequently its reaction to Canadian conditions where it has demonstrated its ability to increase over 300 per cent in a single year and where its presence results in severe damage to our corn crop, cannot but be of interest and value.

The larvae of the European corn borer normally winter in corn stalks or stubble, either standing or lying on the ground. Almost any other not absolutely submerged shelter, from corn leaf on the ground to the centre of the cob in the crib, will serve for successful wintering. In the spring as soon as the weather warms up, the larvae do a variable amount of boring and possibly feeding in preparing the pupal chambers from which an outlet for the escape of the adult is made.

Pupation in the field in 1921 began on May 30th, being practically complete by June 22d, though one or two larvae were taken in the following week. Adults began to emerge June 16th and by July 4th 90 per cent of the moths had issued, the balance following more slowly; a small percentage failed to develop.

In the laboratory where the whole process of development was delayed, pupation did not begin until June 6th, ten days later. The males began to pupate 7 days before the females, outnumbering them until just before the end of the pupation period. Similarly with the moths, the males began to emerge about 4 days before the females and exceeded them in number until just before the end of the emergence period, which extended from June 29th to August 12th. The duration of the pupation period of the males varied from 8 to 18 days, an average of 12.33 days, while for the females it was distinctly less, from 7 to 17 days, an average of 11.29. At the laboratory located a little further inland the average durations, however, were 12 days for males and 10.19 for females, a distinctly more rapid rate.

[1]A joint progress report of the life history studies carried on at the laboratories of the Dominion and Ontario Departments of Agriculture in the season of 1921, at Port Stanley, Ontario, Canada.

The male moths lived in confinement for from 6 to 21 days, averaging 13 days, while the females lived for from 10 to 31 days, averaging 17.4 days, with a pre-oviposition period (20 females) of from 3 to 9 days, averaging 4 days. After this pre-oviposition period they laid from 95 to 988 eggs per female, at the rate of from 12-231, an average of 75.3 eggs per day, in masses containing from 1-64 eggs, an average of 33 per mass. All of the eggs kept under observation hatched. The duration of this stage was from 3 to 8 days, averaging for the period between June 28th and August 2d 4.71 days.

In the field a study of the incidence of egg laying on corn planted on May 31st in a field adjacent to the northern margin of an old corn patch of 1920 at this time in oats and barley, was started. The moths began to emerge on June 18th from the old stubble in the standing grain, and eggs were not found until July 1st when 5 masses were secured from 100 plants though a most careful search was maintained in the intervening period of 14 days; on July 3d 15 masses were secured on approximately 200 plants, at which time egg laying was becoming general and some masses were observed to be hatching. The corn at this time was from 9-20 inches high. No eggs were laid until the corn averaged about 15 inches in height. In the interval the adults were, without doubt, flying southwest to another field planted on May 18th, which at this time was markedly in advance of the field under observation in development and finally suffered a loss of 65%. The field under study on the north, however, was but 63.2% infested and the loss would not exceed 5%.

The first eggs taken in the season, however, were found in the field June 21st and by July 5 hatching was general and the infestation was showing up very clearly on the unrolling leaves where the newly hatched larvae were feeding at the base. The evidence of attack became clearly marked in the first week in July and by the second week the tassels were falling on the early planted flint and sweet corn. As the plant increased in length and the larvae on the rolled up leaves were exposed to light, they bored into the stalks, which by the end of July in the early planted corn began to break over.

By the third week in July in the very early sweet corn, and to a much less extent in the flint, the majority of the larvae were full grown. At that time a very small second brood developed in the very earliest planted sweet corn, involving but a fraction of one percent of the larvae. In this sweet corn 10 pupae in all were collected between July 21st and 26th and 4 pupae were secured from larvae collected at the same time. From these pupae, after a period of 13 days, 2 male moths and

1 female moth were reared. The female laid fertile eggs, the larvae from which established themselves on a corn plant in an experimental cage. The only other evidences of the second brood were 1 pupa and 2 female pupal cases from the earliest flint corn, an adult male in late July, an egg mass found on August 9th and a few 3d instar larvae taken in August.

The larvae in all varieties of the later corn, matured distinctly later on the average and showed no signs of developing a second brood, but prepared for winter about the middle of August and where not disturbed, would probably not move until spring. At harvest time about the last of August and in early September in a flint corn field showing 70% total loss, the estimated number of larvae per acre was 191,800. Of these 27% were within 12 inches of the ground and a four inch stubble carried 28,079 larvae, 6.82% of the larval population.

There was no movement of any import in the standing field corn in the fall, the distribution in the middle of October being practically the same as at the end of August. However, there is a noticeable movement outward and downward in the stalks in shock, but none of any importance from the shock to the ground and neighbouring stubble.

The date of sowing was closely correlated with the degree of infestation, the larval population and the total loss both in experimental and field conditions. In general, corn sown before May 24th was either practically ruined or suffered severe loss; that sown between May 24th and June 1st was heavily infested but suffered relatively less or but slight actual loss depending of course upon the type of corn; while the corn sown after June 1st, although in some cases showing a fairly high percentage of infestation carried few larvae and practically no loss except in the case of sweet corn. Thus on one farm of the three corn patches within 100 yards of each other, the sweet corn sown April 25th carried a larval population of 234,200 per acre with a loss of 100%; sweet corn planted June 1st developed an infestation of 75% and carried a larval population of 80,000 per acre with a loss of 20% while flint (smut nose yellow) planted May 22d, only carried 54,400 per acre, a stalk infestation of 67% and a total loss of not more than 10%. The sweet corn here doubtless protecting the flint by attracting a large number of the moths.

In the experimental plots the effect of the date of planting shows up most clearly, as can be seen in the tabulation below, though here the loss was slight and the larval population meagre, the corn all being planted after May 24th.

EFFECT OF DATE OF PLANTING ON INFESTATION

Variety Grown	Date	Per cent of stocks infested	Per cent of stocks broken over	Per cent of cobs infested
Golden Bantam sweet corn	May 24	30.18	16.93	16.9
	May 31	34.4	20.00	2.14
	June 3	15.33	7.66	1.89
	June 9	7.52	4.30	1.19
Dent Corn Early Leaming	May 31	24.30	69.44	.4
	June 3	13.45	1.50	.99
	June 9	8.11	1.62	1.17
Golden Glow	May 28	53.42	17.81	2.12
	June 3	21.08	9.73	.99
	June 9	7.44	4.65	.63
Wisconsin No. 1	May 28	55.44	16.14	2.65
	June 3	15.61	5.35	1.29
	June 9	3.66	2.44	1.16
Flint Corn Salzers' North Dakota	May 28	70.9	20.77	13.31
	June 3	10.62	10.12	3.77
	June 9	14.74	2.17	4.11
Compton's Early	May 28	82.4	50.00	10.47
	June 3	44.14	17.79	9.68
	June 9	15.10	4.17	3.45
Smut Nose Yellow	May 31	30.14	11.41	6.10
	June 3	28.57	14.29	4.11
	June 9	3.45	.86	1.89

The larval population in badly infested fields attained enormous magnitudes; a dent corn field sown May 18th carried an estimated total of 294,152 per acre, a flint field sown on the same day suffered a total loss of at least 65%, supported a total of 258,400 per acre and left when cut, in the stubble (less than 4 inches in height) and the crop refuse, a residue of 43,488 caterpillars going into the winter.

In general, all things considered, there seems to be no marked preference for any particular type or variety of corn. The severe loss associated with sweet corns and the flint varieties being due to the early planting, the ability of the larvae to establish themselves and the small dimension of the stalks. The obvious relatively slight loss in the dent corns being due to the later planting, its vastly greater bulk and its harder and coarser texture preventing a large proportion of the larvae establishing themselves in the first instar.

THE INFESTATION OF PLANTS OTHER THAN CORN

About the middle of July in the very severely infested fields of early sweet corn, to a less extent in severely infested flint and to a very slight extent in dent corn except in the one severely injured field, the nearly full grown and full grown larvae become restless. At this time large numbers of them leave the now breaking, shrivelling and drying corn stalks and carry on an apparently haphazard migration throughout a period of about two weeks. In the course of this migration as many as 24,400 larvae per acre found their way into the weeds in one field

of sweet corn sown April 25th. Others doubtless returned to the corn plants. Considerable feeding was done in the larger weeds, the pigweeds, the lamb's quarters and barnyard grass breaking over in a high percentage of cases. The barnyard grass was as high as 88% infested and in one instance a plant with 26 stems was found to contain 17 larvae. The weeds infested in this field in the order of frequency were: barnyard grass (*Echinochloa crus-galli*, Beauv.), redroot pigweed (*Amaranthus retroflexus L.*), yellow fox-tail (*Setaria glauca* Beauv.), lamb's quarters (*Chenopodium album* L.), tumble weed or Russian thistle (*Sal-sola* var. *tenuifolia*, G. F. W. Mey), green fox-tail (*Setaria viridis* Beauv:), lady's thumb (*Polygonum persicaria* L.), wild buckwheat (*Polygonum convolvulus* L.), ground cherry (*Physalis heterophylla* Nees); other weeds present but not infested were : purslane, Canada thistle, bitter sweet, milkweed and crab grass. However, throughout the district of the weeds found to be infested in additon to the above the following can be listed: orchard grass (*Dactylis glomerata* L.), Canada thistle (*Cirsium arvense* Scop.), wild sunflower (*Helianthus sp.*), blue weed or viper's bugloss (*Echium vulgare* L.), ragweed (*Ambrosia artemisiifolia* L.); mullein (*Verbascum thapsus* L.), goldenrod (*Solidago sp.*), old witchgrass (*Panicum capillare* L.), yarrow (*Achillea millefolium* L.), burdock (*Arctium minus* Bernh.)

In cultivated crops and flowers larvae have been secured in the field feeding in dahlia, geranium, aster, golden glow, beets, mangolds, tomatoes (fruit), beans, oats, squash vines, broom corn, Sudan grass, early amber sugar cane, Hungarian grass and Mann's Wonder sorghum.

No success was achieved in establishing larvae upon a long series of common weeds by attaching eggs laid upon a slip of corn leaf. The eggs hatched but the larvae rarely were able to infest the plant. In a series of experiments with paired adults caged over 35 common cultivated vegetables and flowers, the larvae in very small numbers established themselves upon mangolds, potatoes, celery, cauliflower, peas, beans, peppers, eggplant, radish (gone to seed), salvia and aster. Summing up, however, the entire infestation in the open of plants other than corn, with the exception of the dahlias, possibly barnyard grass and Mann's Wonder sorghum, was due entirely to the migrating larvae. These larvae particularly in the weeds together with those in the corn stalks, stubble and refuse have gone into the winter in very large numbers with every prospect of coming through successfully and giving rise to an increased infestation in 1922.

PRESIDENT ARTHUR GIBSON: The next paper is by L. S. McLaine.

THE SPREAD OF EUROPEAN CORN BORER IN SOUTHERN ONTARIO

By L. S. McLaine, *Ottawa, Can.*

When the European Corn Borer was realized to be a serious pest, that is, in the summer of 1918, the Canada Department of Agriculture took steps to warn the general public of the danger of introducing this pest into Canada, and also carried on investigations to determine the amount of corn and other products likely to harbour the borer that had been imported into the Dominion from the infested districts in Massachusetts. As a result of these investigations scouting for the pest in the maritime provinces was carried on during the summer of 1919.

With the discovery of the insect in western New York in the fall of that year, the attention of the Department was directed to the possibility of the pest having spread into the province of Ontario. Some scouting was done in Welland county and along the Niagara River that fall, but was soon discontinued on account of the lateness of the season and the unfavourable climatic conditions. Plans were made, however, to resume the scouting in this territory the following summer.

On August 10th, 1920. the first infestation was found near Lorraine Station, Humberstone township, Welland county, Ont. The larvae were small in size and were collected in a field of ensilage corn. A preliminary survey of the infestation showed that it was exceedingly light, but widely scattered. On August 22d, a farmer living near St. Thomas, Ontario, submitted some samples of larvae found in his field corn and which were readily identified as caterpillars of the European Corn Borer. A prompt examination of this district showed the degree of infestation to be much greater than that in Welland county.

With the co-operation of the Ontario Department of Agriculture extensive scouting was started at once. The extent of the infestations exceeded by far anything that had been anticipated and as the season was advancing rapidly, the scouting had to be carried on at undue speed.

At the close of the scouting work it was found that there were two distinct infestations in southern Ontario, the first centering about Welland county, and the second centering about Middlesex and Elgin counties. During the scouting season one hundred and five townships in thirteen counties were examined, thirty-five of which were found infested by this insect. The area found infested covered approximately 2,780 square miles.

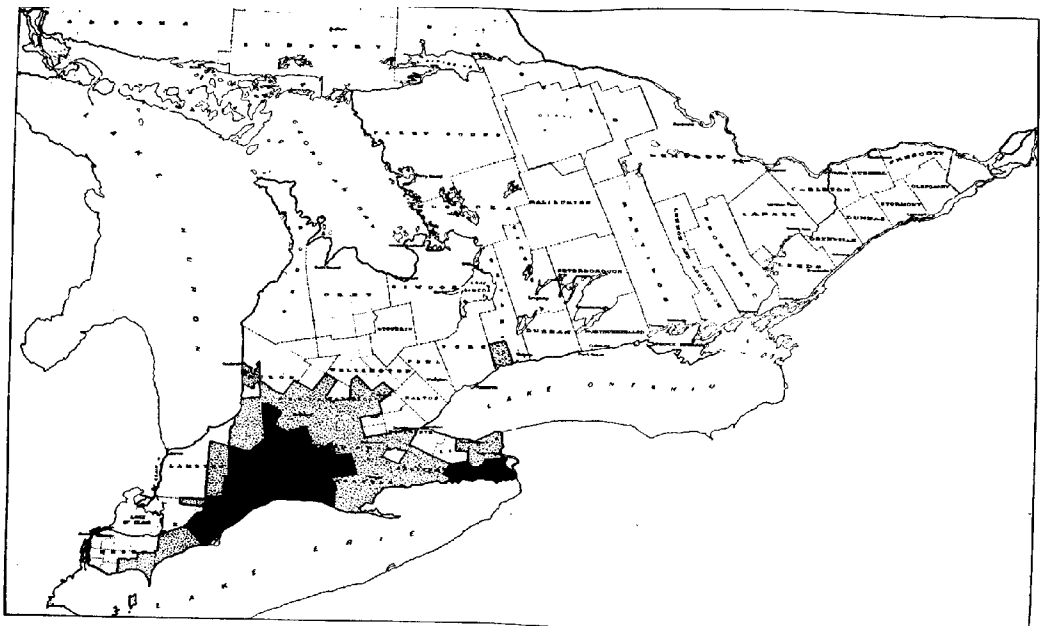

Fig. 7.—Map of Ontario showing the distribution of the European Corn Borer. Black indicates area infested in 1920 and gray the area infested in 1921(Original)

The season of 1921 was unusual in several respects, the continued hot dry weather in June and July caused all vegetation to develop with abnormal rapidity, and it was necessary to start the scouting work two weeks previously to the time originally planned. The scouting was actually started on August 1st and completed by October 3d. During this period one hundred and ninety-seven townships were scouted, of which sixty-five were found infested, these added to the thirty-five townships found infested in 1920 make a total of one hundred townships infested to date. The area found infested by the scouting this past season is approximately 4,910 square miles, which, in addition to the 2,780 square miles infested in 1920, makes a total of 7,690 square miles now infested by the European Corn Borer in this district.

The following townships in Ontario are infested at the present time: Oakland, Brantford, Burford, and Onondaga in the county of Brant; the seven townships in Elgin county; Gosfield South, Mersea and Pelee Island in Essex county; nine out of ten townships in Haldimand county, the tenth township was not scouted on account of the small amount of corn grown, but was included in the quarantine; Goderich, Hay, Stephen, Tuckersmith and Usborne in Huron county; Gore of Camden, Harwich, Howard, Orford, Raleigh, Romney, Tilbury East and Zone in Kent county; Brooke, Euphemia and Warwick in Lambton county; Clinton, Grantham, Louth and Niagara in Lincoln county; the fifteen townships in Middlesex county; the eight townships in Norfolk county; Pickering in Ontario county; the eleven townships in Oxford county; Blanshard, Downie, Easthope North, Easthope South, Ellice, Fullerton, Hibbert, Logan and Mornington in Perth county; Waterloo, Wilmot and Woolwich in Waterloo county; the eight townships in Welland county; Guelph in Wellington county; and Lancaster in Wentworth county.

The degree of infestation is heaviest in Elgin and Middlesex counties, and on the outer edges of the infested area borers were very hard to find.

It is also to be hoped that the past season was an unusually favourable one for the European corn borer, for there has been a general spread from practically all points of the 1920 area, but the most noticeable spread has been north, northeast and east.

The scouting work of 1920 showed that there were two distinct infestations in the province at that time, and the results of this past summer's work appear to bear out that conclusion. This season the scouts had no difficulty in making several collections of larvae in the townships adjacent to the western end of the old Welland infestation, and in townships adjacent to the eastern end of the Middlesex and

Elgin infestation, whereas great difficulty was encountered in locating borers in the center townships, that is, between the two infestations.

The infestation is exceedingly light on the extreme western edge of the infested area, that is, in Kent and Essex counties, in fact the only collections in the townships found infested in these counties this year, were taken along the main highway which runs east and west. The spread into this area may be due to artificial spread, either from carriers such as automobiles, or from infested corn refuse washed up on the shore of the lake, as the highway is adjacent to the lake in this district.

The discovery of the borer on the Lake Huron shore was made late in the season, and only a single collection of larvae was taken in the township of Goderich. As the neighboring township was found to be lightly infested, it appears as if the infestation in Goderich township may be due to an exceptionally long flight of the adult moths.

The only isolated infestation was found in Pickering township, about twenty miles east of Toronto and bordering Lake Ontario. The collection of larvae was made in the town of Pickering. Although the entire township, as well as the neighboring townships were carefully rescouted no further collections were taken. The nearest infestation to this point is in Linclon county approximately forty-five miles away.

Upon the completion of the scouting season in 1920, a domestic quarantine was placed on the infested area prohibiting the movement of corn stalks, broom corn, green sweet corn, roasting ears, corn on cob and corn cobs from the area placed under embargo. Exception was made however, to shipments of seed corn on the cob consigned to recognized fairs and exhibitions, which were inspected immediately upon arrival at destination. This quarantine was amended in May 1921, and three additional amendments were passed during the summer and early fall, quarantining the additional townships found infested.

In order to bring the attention of the general public to this embargo, warning notices were placed at the intersection of every road leading out of the quarantined area. In addition, large canvas banners, 2½ feet by 11 feet were stretched across the main automobile highways leading out of the district. Automobiles were stopped and searched on the main highways on Sundays and holidays for evasions of the quarantine. A careful watch was also kept on all markets and fall fairs. It was found that live stock men were in the habit of taking corn stalks as fodder for their live stock exhibitions at the larger shows, thus making it necessary to station inspectors at such fairs.

Although no direct evidence has been secured as to the origin of the outbreak of the European corn borer, this may have been due in Elgin and Middlesex counties to importations of broom corn from Europe. From correspondence, it has been learned that all Canadian broom manufacturers prefer to use broom corn grown on this continent, but in 1909-10 there was apparently a shortage of this product and one firm at least located in this district, imported large quantities of corn from Central Europe.

PRESIDENT ARTHUR GIBSON: The next paper is by Messrs. Crawford and Spencer.

THE EUROPEAN CORN BORER CONTROL MEASURES

Joint results of studies in 1921, of H. G. CRAWFORD, *Dominion Department of Entomology, Ottawa, Canada, and* G. J. SPENCER, *Ontario Agricultural College, Guelph, Canada.*

Complete control measures for the European Corn Borer in Canada have not as yet been perfected. Many facts have been worked out with regard to its life history, enabling us to outline certain practices which will go a long way towards keeping it in check in the districts where it is most prevalent. The question of limiting it to these areas will be discussed later.

We know of no means of destroying the European Corn Borer in the pupal, moth or egg stages. But since it spends about ten months of the year as a larva, it is in that stage that we can best bring about its destruction.

At harvest time the borer is full grown and may be found in all parts of the corn stalk except the leaves, from the tassel down to the tap root. Standing stubble or stubble plowed out and left on the surface with debris of all sizes, and corn stalks left in stooks or in standing sheaves or lying on the ground, constitute ideal quarters for borers to winter in, with remarkably low percentage of mortality.

Control: falls under two phases—

Phase 1. The destruction of the borer in the stems and cobs of corn.

Phase 2. The destruction of the borer in the stubble and refuse on the field after the crop has been removed.

PHASE 1. *The destruction of the borer in the stem.* By cutting the corn as low and as early as is compatible with maturity, by far the largest proportion of borers in a field can be removed in the stems. The longer the stalks are left intact, the further down the borers will work and if all are not mature but are still feeding, the more damage they do. The

handling of the corn during harvesting operations will cause some borers to become restless and to leave the stalks. This is unavoidable.

A silo extension campaign should be strenuously waged.

The cutting box kills most of the borers; those that escape the knives are accounted for by the heat and the fermentation of the silage. A very few larvae in several inch-lengths of stalk, that have escaped the knives at filling time, walk up the sides of the silo and escape. Some escape from the stalks at cutting time, into the machine. Hens were observed to eat these greedily.

Where There is no Silo

In dealing with the stalks, the handling of corn for feeding as stover and of husking corn, presents the chief problem.

The removal of stalks from the field directly after harvest so as to allow of the *early plowing of the field, presents at present the greatest single difficulty in control measures.*

Farmers prefer to leave the stooks in the field until dry, rather than haul them to some other field or land, to dry sufficiently to allow of their being put into the barn without moulding.

We recommend the shredding where possible of all corn stalks used as fodder. This insures many of the borers being killed and the more complete eating of the corn by stock. The processs of shredding causes many larvae to leave their burrows and they then fall among the grain that shells out from the cobs. It was found that 80% of these were killed. When shredding is not practicable, the stalks after feeding and stalks used as bedding should not be thrown out into manure heaps as is usually done, but should be piled separately in an enclosure where the cattle cannot scatter them around, and should be burned. The fate of larvae in stalks trodden into manure and the effectiveness of this means of dealing with waste stalks, has not yet been completely worked out. It is still under investigation and observation.

Some farmers have been in the habit of burning waste stalks every week; they claim that it gives very little extra trouble. In any case the waste pile should be burned by the end of May, before pupation commences. If corn stalks are wet and are densely piled, the larvae leave the bottom layers early in spring and migrate to the upper three inches. Where the upper surface of the pile is dry, it can be readily burned over before June. In piles of dry stalks, the larvae do not migrate to the top and will pupate in their burrows from ground level right up through the mass and the moths will all emerge. In one case, it was found that all moths had emerged from a load of stalks 4 ft. 10 inches high, from

the very bottom of the pile. This pile being quite dry it burned completely to the ground.

Ears of corn that have been husked in the field should be hauled off with the stalks as soon after harvest as possible so as to allow of the early plowing of the field, and the waste husks should be burned.

Since this year's corn crop was so heavy (1920) several farmers in the infested districts, after filling and refilling their silos and selling what they could of the crop, burned all the rest of it in the field. Drastic measures, but very praiseworthy.

The stalks of sweet corn grown for factories should be cut after harvest, hauled off, fed and the remains treated as outlined—or if not used for feed, should be cut in the field with a mower, raked into windrows and, when thoroughly dry, burned. Some factories sell their corn stalks and cobs that were grown on contract; some ensile it as well as the cobs after being shelled at the factory, and sell the ensilage. This whole practice is to be recommended, since they may harbor larvae. Corn cobs after being shelled, should be burned (if not used as fuel) in the waste pile, rather than be left lying around the yard.

SECOND PHASE. "The destruction of larvae remaining in stubble and crop refuse in the field after the crop has been removed."

Stubble in any position and debris on the surface and weeds growing among corn, can and do harbor larvae.

In stubble we have found as high as 11000 to 14360 larvae per acre.

In debris we have found as high as 31000 larvae per acre.

In weeds we have found as high as 24000 larvae per acre.

Stubble left standing in the field or plowed out and left lying on the surface, constitutes almost ideal sheltering conditions for over wintering larvae. It has been found impracticable to dig or plow out stubble in order to pile and burn it.

Under conditions that existed in Ontario 1920 and in the fall of 1921, "we have found that *the plowing under to a depth of 6 inches, of stubble and debris, as early as possible after the removal of the crop is the factor of control second only in importance to the silo.* About the middle of September is the latest safe date for plowing to work, at Port Stanley, Ont. if the larvae are to be forced to leave the stubble in largest possible numbers.

The efficiency of plowing is in direct ratio to its earliness. By the end of October, the upward migration has ceased to be of much consequence and larvae in stubble and debris, plowed under at and after that date, will remain underground through the winter without suffering heavy mortality and migrate out before the last of April the following spring.

In dry sandy loam, bundles of stalks were buried with a larval expectation of at least fifty per bundle, and were taken and examined at intervals. The results follow:—

Date buried,	Sept. 4.						
Dates removed.	Sept. 20	Sept. 28	Oct. 12	Oct. 25	Nov. 2	Nov. 1.	
	53	8	4	5	2	1	larvae.[3]

Plowing must be done thoroughly so as to cover all stubble and debris. This is materially helped by rolling immediately the crop is off, as rolling crushes open from 95% to 97% of the stubble, flattens down the stubble and weeds, kills some borers and destroys good wintering quarters for others, because it greatly facilitates moisture getting into the stalks and consequently, their earlier decay. Moreover, larvae leave moist soil sooner than dry soil. Under dry conditions, the whole season may be necessary to get all larvae in plowed under stubble, to come to the surface. Early plowing kills some borers but is chiefly of importance because it forces the vast majority of them to come to the surface. If any debris is around, they enter it.

On stubble land that has not been cleanly plowed down, rolling *after plowing* undoubtedly forces some outstanding stalks under the surface. Rolling of land that has been well and cleanly plowed, has been found undesirable because it delays the movement upwards, of the borers, and facilitates their migration to surrounding fields, when they do come up.

This movement upwards, of the larvae, is influenced by the type of soil in which infested material is buried, by temperature and by moisture. Just what these conditions are, has not been worked out yet. Reactions vary according to the time and consequently the *temperature* of the season.

Comparison of rates of larvae leaving various types of soil, in order of degree. Larvae used—at least 300 in each case.

Soils	*Larvae regained*	*Expectation*
1. Moist sand loam	29	300
2. Dry sand loam	41	
3. Wet clay	49	
4. Sand	54	
5. Dry sand loam (single layers)	72	
6. Dry clay	106	

In some experiments the larvae died in material that was buried early in August. In the majority of cases, however, *the earlier the plowing, the sooner the larvae emerged from the soil.* This shows that in August, larvae emerged rapidly and migrated to neighbouring fields.

In September especially on land plowed and sown to wheat, they did not migrate much to other fields, but simply disappeared. *Spring plowing* will kill a large number (how large a percentage is not known) but many mature. If spring plowing is done late, up to within a short time of pupation of the borers, the larvae will emerge after being plowed under. But if just ready to pupate, and then plowed down, they pupate in the stalks under ground and a high percentage of adults emerge from pupal cases, but none of them can reach the surface, from lower than 2 inches and the wings of the very few that do emerge are so battered that they cannot fly and soon perish.

The Futility of Individual isolated cases of cleaning up.

Unless a corn field is a long distance from other corn fields and is shut in by woods, the efforts of individual farmers to control the borer by thorough clean-up methods, are utterly futile. The movement must be community wide, if it is to succeed at all.

Late Planting. As has been pointed out, moths lay eggs most freely on the earliest sown and consequently the tallest, corn. Late planting of the main crop will undoubtedly reduce its degree of infestation. Some corn may have to be planted earlier to act as a catch crop, especially where very large acreages are grown in any one place in the infested regions. Trap crops *may* function if sown in fairly wide strips down one side of a field nearest to last years corn field. If this succeeds in attracting most of the infestation, it should be removed and fed at once and the waste parts burned when dry—or destroyed entirely if heavily infested, well before the main crop is harvested.

These control measures are not expensive to execute. Usually only one field on a farm is involved. Corn is such an important crop that the extra care necessary in thorough cleaning up operations will well repay time spent on them and any inconvenience involved.

Natural Control

NATURAL FACTORS IN THE CONTROL OF THE EUROPEAN CORN BORER.

1. Natural agencies, weather and winter, killed less than 3% of borers in winter 1920-1921.

2. In spring of 1920, the tachina fly, *Exorista nigripalpis* Town, accounted for so high as 13% larvae in one field with an average of 8% for that field. For the district an average of 3 or 4% would be fairly true. It cannot yet be considered of much consequence in control.

3. The insect that probably does more good than any other, is the spotted ladybird beetle, *Ceratomegilla fuscilabris* (*Megilla maculata*) which was repeatedly seen to eat every egg mass it found. These bee-

tles were kept in cages and were fed egg masses, which they consumed entirely. No Hymenopterous parasites were reared from larvae or eggs.

PRESIDENT ARTHUR GIBSON: The final paper in the series is by Mr. E. P. Felt.

THE EUROPEAN CORN BORER IN NEW YORK STATE[1]

By E. P. FELT, *State Entomologist, Albany, N. Y.*

The exceptionally severe and wide spread injury by the corn ear worm, *Chloridea obsoleta* Fabr., has been particularly unfortunate in that it has attracted general attention to a passing phenomenon and thus in considerable measure obscured a really serious problem.

It happens that the European Corn Borer, *Pyrausta nubilalis* Hubn., has as yet caused relatively little damage in New York State, though there has been appreciable injury to comparatively small plantings. The development of the last few years make it impossible to be certain as to the cause for this comparative immunity. The exceptionally thorough and general clean up in the eastern infested area in the spring of 1919 presumably had an important effect upon the abundance of the borers and even yet the pest is not numerous in that section, a fifteen per-cent stalk infestation being near the maximum. This work was on an exterminative basis, consequently no checks were left.

There was in the western part of New York State a thorough clean up during the fall of 1920 and the spring of 1921 by the Federal Government in the more badly infested section, centering on Silver Creek. Examinations and comparisons the past summer showed little difference between the cleaned up areas and the conditions on the nearby Indian Reservation where a forty per-cent stalk infestation was not difficult to find. There is no question but what the clean up destroyed hosts of borers. It is possible that climatic conditions were exceptionally favorable and enabled the few remaining insects to transform and deposit a maximum number of eggs and thus offset in considerable measure the beneficent results which should follow general clean up work. It has been suggested that the operations may have been nullified to a considerable extent by moths drifting from another badly infested area. This must be considered simply as a possibility and as yet not even the probability has been established.

[1]Some of the data given in this paper have been secured by the writer in his capacity as Collaborator, Bureau of Entomology, U. S. Department of Agriculture.

The spread in New York State has been moderate, approximately a six mile extension on all boundaries, though the increase in the known infested area has been somewhat greater, due presumably to the difficulty of establishing the actual limits each season. There are now nearly 5000 square miles infested in New York State.

The similarity of conditions last summer in the infested areas of eastern and western New York and Ontario, Can., is further shown by the finding of the first pupa in the field at Scotia and Port Stanley May 30th, the first moths at Scotia and Silver Creek June 16th, an empty pupal case at Port Stanley on the same date, and the first egg mass at Scotia June 16th, at Silver Creek June 22d and at Port Stanley June 25th. Furthermore, in each of these localities, there was a partial, though very small, second generation.

The season of 1921 showed a marked increase in injury in the badly infested area in Ontario, and since climatic and agricultural conditions in that section and in eastern and western New York, particularly the latter, are very nearly identical, it may be that this development is prognostic for the New York areas. Here again, we are venturing into the realm of theory and this latter, when applied to the interpretation of conditions in eastern New York as compared with those in eastern Massachusetts has not always been entirely satisfactory.

It is certain that in portions of both the eastern and western infested areas in New York State, there are enough borers so that their progeny under exceptionally favorable conditions, such as appear to have obtained last year, might cause very serious losses, particularly to the early planted sweet and Flint corn. This is a possibility, which by some might be construed as a probability.

The close studies of the corn borer under New York conditions for the past three seasons have failed to show habitual breeding of this insect in any plant except corn and the occurrence of the borers in the stems of weeds, etc. has been restricted to plants in the near vicinity of corn. This relative freedom of other plants from infestation has been reflected in the modified quarantine recently promulgated and restricted in its application to corn, broom corn, all sorghums and sudan grass. There is ground for fearing a more general infestation following an increase in the relative number of the borers and should this occur, it would inevitably mean an extension of quarantine measures to other plants and in these latter there would probably be several important garden products.

It is obvious that national and state agencies cannot indefinitely continue to clean up the constantly increasing infested areas and it

therefore follows that repressive measures, which appear practicable to the farmer must be devised or serious losses may follow. The most promising of these were outlined at the somewhat recent Sandusky —St. Thomas conference and need not be discussed in this connection.

The corn ear worm situation and the relatively slight injury from European Corn Borer has resulted in comparatively little attention being given to the latter in New York State, in spite of its potential importance. It has seemed to the writer that conditions entirely justified the pointing out of the possibility, if not probability, of serious injury following a continuation of the corn borer conditions outlined above and the calling attention to the fact, that in the event of such developments, there would probably be a restoration and enforcement of the quarantine as originally promulgated. An effort is being made to interest the corn growers along these lines and in view of the fact that our badly infested corn, mostly the early planted corn, occupies a comparatively small proportion of the acreage, it seems entirely practicable and under present conditions desirable to emphasize the need of giving special attention to that part of the crop, though it would naturally follow that all corn fodder in infested areas would be worked up a little more carefully than has previously been the case.

A redeeming feature of the situation is found in the fact that infestation by the European Corn Borer is rarely uniform throughout the territory. There are marked variations. Many of these presumably can be explained by the difference between early and late planting and to some extent by variations in nearby sources of infestation. There is still great need of ascertaining the limitations of this insect under field conditions so that they may be used to advantage in ordinary farm practice.

MR. T. J. HEADLEE: I would like to ask concerning control measures? If the individual farmer should practice the best combination of cultural methods that we have heard this afternoon, would he obtain freedom or approximate freedom the following year, though his neighbors did nothing to control the insect?

MR. G. J. SPENCER: I would say no. An investigation was conducted on a badly infested field last year. The field was gone over with a potato digger. It was also gone over with forks, and was handpicked, and yet the infestation this year was about the same as the previous year.

MR. E. P. FELT: Was this in the badly infested area?

MR. G. J. SPENCER: Right in the middle of the badly infested area—right alongside of it.

There was one instance where it was effective. It may have been due to slightly later planting. It was an isolated field hedged in on two sides by woods, and this field infested last year was this year almost free, due I think to the lateness of planting; although the man did carry out an extensive cleanup campaign last fall.

MR. W. R. WALTON: I would like to ask Mr. Spencer if I may whether he finds that the physical condition of the soil affects migration of the larvae? Does he not find that migration is less in heavy soil than in light soil?

MR. G. J. SPENCER: I will refer that to Mr. Crawford.

MR. H. G. CRAWFORD: In connection with this point I might say that we carried out a series of experiments, burying ten stalks in loose bundles and single layers, at depths of six inches, throughout the season. The chief governing factor in the early season in the rate of larval emergence from various buried stalks was the moisture of the soil. They came up through very heavy clay soil to all practical purposes at the same rate of speed as they came up through sand. In fact, sand soil is the most retentive of larvae of any soil used in the experiments. Some of these experiments were put in between the fourth and the eleventh of September, so there was no temperature factor slowing them up in the sand at least during the first part of the season.

MR. W. R. WALTON: It seems curious that yours seem to be directly opposite to the results which we secured in similar experiments.

MR. H. G. CRAWFORD: In regard to the matter of control for the individual farmer—for effective results it has to be done on a community basis. However, there is the point to bear in mind that the early planted corn is very severely infested and ruined, in a case of sweet corn—one hundred per cent. loss. In the same vicinity the late planted corn, though fairly heavily infested, is not severely damaged, and the individual farmer could thus stop *severe* loss comparatively easily. In our efforts next year to get a group of the farmers to follow as many of our suggestions as possible, we are going to lay particular emphasis on putting corn in as late as is safe in the community. If they put it in as late as they feel, as practical growers, is safe, it will cut down the loss; though we will still be carrying infestations up to sixty, seventy and in some cases eighty per cent.

MR. E. P. FELT: Has Mr. Crawford any definite information, or an approximate idea of the relative area in the badly infested section, which was severely damaged by corn borer? I asked that question last fall. Has he an answer now?

MR. H. G. CRAWFORD: I have not. It would involve the study of every corn field involved, as one field will be less than twenty-five

per cent. *infested* and the next one will be sixty-five per cent. *loss*. This makes the determination of the general dollars and cents loss almost an impossibility unless one looks at them and canvasses every field oneself. An untrained man who has not really worked over a set of cobs and can tell the percentage of kernels involved and the stalk loss associated therewith, cannot give valid information. I am sorry, Dr. Felt, that it is impossible to give you the information.

PRESIDENT ARTHUR GIBSON: The next paper is by R. C. Treherne.

THE ONION MAGGOT IN BRITISH COLUMBIA UNDER IRRIGATED CONDITIONS

By R. C. TREHERNE, *Ottawa, Can.*

(Withdrawn for publication in the 52d Report of the Entomological Society of Ontario.)

PRESIDENT ARTHUR GIBSON: The next paper is by L. Caesar.

THE CABBAGE ROOT MAGGOT

By L. CAESAR, *Guelph, Canada*

(Withdrawn for publication in the 52d Report of the Entomological Society of Ontario.)

PRESIDENT ARTHUT GIBSON: The next paper is by Glenn W. Herrick.

THE LIFE HISTORY, HABITS AND INJURIES OF THE MAPLE CASE-BEARER

By GLENN W. HERRICK, *Ithaca, N. Y.*

(Withdrawn for publication elsewhere.)

PRESIDENT ARTHUR GIBSON: The next paper is by J. W. McColloch.

LONGEVITY OF THE LARVAL STAGE OF THE CADELLE[1]

By J. W. MCCOLLOCH, *Associate Entomologist, Kansas Agricultural Experiment Station*

The Cadelle (*Tenebroides mauritanicus* Linn.) in spite of its importance as a pest of stored grain and grain products has not been the subject of any extensive life history studies. Curtis[2] (p. 332) reports the rearing of a beetle by Kirkup from a Spanish almond. The larva lived fifteen months in addition to the period it had been in existence before its discovery and the beetle remained alive for 21 months.

[1]Contribution No. 72 from the Entomological Laboratory, Kansas State Agricultural College and Experiment Station.

[2]Curtis, John. 1883 Farm Insects. John Van Voorst, London.

Herrick[3] (p. 234) discusses the observations made by Slingerland, who reared this insect in wheat under insectary conditions. He found the egg stage to be about ten days and the larvae lived from August to the following April and May. He concludes from these observations that the life cycle is about one year. Slingerland also found the adults to be longlived, one beetle living nearly a year. Zvierezomb-Zubovsky[4] reared the Cadelle in flour and found it to have one generation a year. The egg stage varied from 7 to 24 days, the larval stage from 98 to 115 days, and the pupal stage frm 8 to 30 days. He states that adults emerging in the fall probably hibernate as do the larvae hatching late in the season. Throughout the most of the literature on economic entomology, this species is said to require one year for its life cycle. It is not the purpose of this paper to give an extended account of the life history, but rather to record certain observations, especially on the longevity of the larval stage. During the past few years the writer has had a number of Cadelle under observation and while the data are meager they are suggestive and indicate the need of a more extended study of this injurious species.

These studies were begun Sept. 7, 1916, when two larvae, each about one-eight of an inch in length, were found in a sack of seed corn. These were placed in separate one-half ounce tin salve boxes containing wheat and wheat bran for food and placed in the cave used for much of the life history work at the Kansas station.[5] One of these lived until July 30, 1918, and the other until August 23, 1919. This prolonged larval life was of such interest that it seemed advisable to obtain newly hatched larvae for futher work.

During July and August, 1918, several adults were placed in cages and 26 eggs were secured. These eggs hatched in from 15 to 18 days, and the larvae were placed in salve boxes as has been described. Ten of these larvae died during 1918, three in 1919, eight in 1920, and two in 1921. One larva is still alive at this writing (Dec. 15, 1921). In addition to these larvae, a number have been collected at various times and placed under observation.

As has been mentioned, the extended life of the larvae has been of special interest. In the case of the two worms collected Sept. 7, 1916,

[3]Herrick, G. W. 1914. Insects Injurious to the Household and Annoying to Man. The Macmillan Co., New York.

[4]Zvierezomb-Zubovsky, O. 1919. On the Biology and Morphology of *Tenebroides mauritanicus* L. Report on the work of the Don Bureau for the Control of Pests of Agricultural Plants for 1918. Rostoff. Abstract in Rev. App. Ent., Vol. 8, Ser. A. pp. 107-108.

[5]McColloch, J. W. 1917. A Method for the Study of Underground Insects. Journ. Econ. Ent., 10: 183-187.

one lived 651 days and the other 1000 days. Of the twenty-six larvae which hatched from eggs, eleven lived an average of 822 days with extremes of 628 and 1248 days. One larva which hatched July 27, 1918, pupated July 16, 1920, giving a larval period of 720 days. Another one that hatched August 17, 1918, transformed July 12, 1921, having lived as a larva 1056 days. A number of worms collected in 1919 also lived two years or more.

The number of molts was determined in a few cases and in one instance in which the larva completed its growth, eleven molts were noted. Table 1 is presented to show the number and frequency of molts of several larvae and is typical of the others under observation. Zvierezomb-Zubovsky[6] records but five molts. He states that larvae molt about 27 to 31 days after hatching, the subsequent molts occuring at intervals of from 9 to 10, 10 to 14 and 20 to 24 days, respectively. About 22 to 27 days after the fourth molt the last skin is shed and the larva is ready to pupate.

TABLE I—SHOWING THE NUMBER AND FREQUENCY OF MOLTS OF CADELLE LARVAE

Larva No.	16.5008	18.1082	18.1092	19.1639	19.1641
Source	Collected Sept. 7, '16	Hatched July 27, '18	Hatched July 27, '18	Collected Oct. 27, '19	Collected Oct. 27, '19
Molts	Oct. 5, '16 July 27, '17 Sept. 14, '17 Sept. 19, '17 Oct. 17, '17 July 15, '18 Sept. 3, '18 Oct. 5, '18 June 25, '19	Sept. 30, '18 Oct. 12, '18 June 20, '19 Aug. 23, '19 Apr. 15, '20 July 23, '20 Aug. 1, '21 Sept. 18, '21 Oct. 10, '21	Sept. 30, '18 Oct. 5, '18 June 20, '19 Aug. 2., '19 Nov. 11, '19 July 16, '20 Aug. 2, '20 July 2, '21 July 16, '21 Aug. 9, '21 Aug. 31, '21	June 25, '20 July 23, '20 Aug. 30, '20 June 3, '21 July 8, '21 July 25, '21 Aug. 12, '21 Aug. 25, '21 Aug. 29, '21 Sept. 26, '21	June 11, '20 June 25, '20 July 23, '20 Aug. 30, '20 June 9, '21 June 16, '21 July 25, '21 Sept. 9, '21 Sept. 30, '21
Remarks	Died	Still alive	Semi-pupa	Still alive	Died

Very little data were secured on the other stages probably because the proper conditions were not offered for pupation. The length of the prepupal stage was obtained in one case and occupied nine days. The pupal stage was determined in two instances and was found to be 12 and 13 days, respectively. The complete life cycle as found in one instance was 1085 days. Should the larva which hatched in 1918 and is still alive complete its development, the life cycle will be approximately four years.

The results of these observations open the question of whether the life cycle is normally one year, as stated in most of the economic literature of this species, or whether it is much longer. While the larvae were reared under conditions somewhat different than those occuring

[6]Op. Cit

in nature, yet the variation was hardly sufficient to cause this difference. The temperature conditions were in close accord with those encountered in many of the places infested by this insect. The food was the same as would be obtained in the ordinary farm granary except that other grain-infesting insects were not present. It is a well known fact that the Cadelle is also carnivorous, feeding on the various stages of other stored grain insects, and it may be that these are essential. The fact that many of the larvae lived two and three years, during which time they were feeding, growing, and molting would indicate that the rearing conditions were favorable. The high mortality after two or three years is probably due to unsuitable conditions for pupation. Herrick[7] (p. 233) records pupation occurring in pine boards, while others state that the larvae crawl into cracks and other sheltered places before transforming. Further experiments are now under way or soon to be started for the purpose of obtaining more data on the life economy of this insect and the factors which influence larval development.

MR. E. P. FELT: May I ask if these larvae were kept with a fairly good supply of food, or was it reduced to pretty near a minimum.

MR. J. W. MCCOLLOCH: They were confined in individual salve boxes filled with food, and this was changed frequently so that if they were feeding on grain alone they obtained plenty. They were usually given both wheat and bran in the same box, and in some cases some flour was added also, and in a few cases we tried to rear them entirely with flour and grain; but we got the best results with wheat and wheat bran.

MR. GLENN W. HERRICK: Do you give them much moisture?

MR. J. W. MCCOLLOCH: Fairly dry.

MR. GLENN W. HERRICK: I have a student carrying on experiments feeding these larvae, watching the gain and growth, and he finds that they desire a great deal of moisture.

MR. J. W. MCCOLLOCH: We have had this experiment going on for 3 or 4 years. In the last two years we have had very dry weather, and they lived in an open granary.

Adjournment: 5.00 p. m.

[7]Op. Cit.

THE STRAWBERRY WEEVIL CUTTING APPLE, TOMATO, AND COTTON BUDS IN TENNESSEE

By S. MARCOVITCH

Agricultural Experiment Station, Knoxville, Tennessee

The strawberry weevil, *Anthonomus signatus* Say, unlike its near relative, the cotton boll-weevil, is known to have several unrelated food plants: for example; the strawberry, blackberry, raspberry, and redbud tree. It is probable, therefore, that its known list of food plants is not exhausted, particularly in more southern localities. After careful observations and breeding experiments, such was found to be the case.

On March 18, 1921, apple buds were examined at Curve, Lauderdale County, Tennessee, and found to have been severed. The cut buds remained on the tree, and were conspicuous by their smaller, shrivelled, appearance. In one cluster five out of seven buds were thus cut. When these aborted-looking buds were opened, eggs were easily found. A little later the adult weevils themselves were noticed on the twigs, and it was easy to see that they were responsible for the cut buds.

To make absolutely sure that no other insect was present, several buds were collected and placed in jars to rear the adults. On April 9, fullgrown larvae were present in the buds. Genuine strawberry weevils emerged from the buds on April 23. By breeding the adults from apple buds, we have practical proof of another food plant that may be credited to the strawberry weevil. The apple trees where the weevils were found are located close to a strawberry patch infested with weevils. Whether the strawberry weevil will continue to breed only in buds of apple trees that are adjacent to strawberry fields remains to be observed.

From conversation with farmers in West Tennessee, it was learned that cut buds were observed on cotton and tomato plants. Experiments were conducted with these plants to see if the strawberry weevil was capable of breeding in them also. On April 25, the newly emerged weevils from the apple buds were placed in a cage with a tomato plant. On May 2 several buds and flower pedicels were found girdled but none cut through. Upon examination, no eggs were observed. The buds were not cut straight across, as is usual, but girdled around the entire pedicel, causing the buds to wither. The strawberry weevil did exactly the same thing when placed in a cage with the common horse nettle, *Solanum carolinense* L., and with a cotton plant, on July 12. The squares of the latter that were girdled measured ¾ of an inch

or less across, and the pedicels about ½ of an inch. The cut squares were examined, but no eggs could be found.

This is in accord with observations made by the writer in Minnesota. There it was found that newly emerged weevils when given fresh buds would girdle them; but in no single instance could eggs be found. It was also learned upon dissection that recently emerged weevils do not contain eggs and are therefore unable to oviposit the same season. It should be noted that newly emerged weevils were used in the cages with the tomato plants. What effect old laying weevils would have on tomato and cotton buds has not been determined. The old weevils have probably all disappeared when cotton squares are put out in the field.

It may be of interest to report here some observations made on other food plants of the weevil that are already known. On March 18, 1921, the buds of the redbud tree, *Cercis canadensis*, were found cut in West Tennessee. The injured buds were smaller and shrivelled, as in the case of the apple, and contained eggs.

On April 29, 1920, the buds of the yellow-flowered cinquefoil, *Potentilla canadensis*, were observed to be severed at Knoxville. These contained eggs from which adults emerged June 2.

Wild blackberry buds were found cut May 4 at Knoxville. These were placed in a breeding jar and adults were obtained June 7.

On June 1, 1921, the weevils were reported to have destroyed practically all of the roses at Curve, Tennessee. Professor Sherman also records the weevil as breeding in and cutting the buds of the roses at Wallace, North Carolina, in 1904.

On April 16, 1920, adults of the strawberry weevil were found in the flowers of the common dogwood. When okra comes into flower, they may be found there too. Frost records the strawberry weevil in the flowers of *Vacciniums*, while Hamilton states that he found them in flowers of *Tilia* and *Rhus*.

With our present knowledge of the food habits of the strawberry weevil, it may be stated that certain plants are used for breeding purposes: namely, the strawberry, blackberry, dewberry, raspberry, yellow-flowered cinquefoil, redbud tree, rose, and apple. Other plants, like the tomato, horse nettle, and cotton, may have their buds cut, but no eggs deposited in them. Finally, the weevil may visit a great variety of plants, such as the dogwood, okra, blueberry, and sumach during their flowering period to obtain pollen.

Scientific Notes

Paradichlorobenzene Records. Report on 18,000 peach trees 6 to 20 years old in Berckmans Brothers Orchards, Mayfield, Hancock County, Georgia, treated with Paradichlorobenzol.

Applied	*Removed*
Oct. 11–14, 1921	Nov. 22–25, 1921

Examined 300 trees various ages and in all soils Nov. 22nd and 25th, 1921—2 live borers.

Examined 55 trees various ages and in all soils February 6, 1922, found 2 borers in 1 Hiley tree 10 yr. old, on red soil.

2 borers in 1 Belle, 7 yr. old, sandy loam soil.

1 borer in 1 Belle 10 yr. old, " " "

Labor for applying and removing paradichlorobenzol on 18,000 trees, $151.38. This is accurate and includes every item of expense of application and removal, but does not include cost of paradichlorobenzol, which was, including freight and hauling, $225.00.

A. L. Q.

The Dipterous Parasite of The Cottony Cushion Scale.—The synonymy of the dipterous parasite, *Cryptochaetum*, has been under discussion for some years and in order to settle the matter the writer collected a good series of individuals and forwarded them to Professor Aldrich for identification. His reply will straighten out the tangle.

"I cannot satisfy myself that *monophlebi* is anything but a synonym of *iceryae*. Both Skuse and Knab were misled by the figures accompanying Williston's first description. Williston had nothing to do with this figure and published afterward a corrected figure of the venation in his species. He distinctly stated that the wings were "short broad," which agrees with his figure published later, but not at all with the figure published in connection with his original description. So I believe you are justified in continuing to call your species *iceryae*."

E. O. Essig

The European red mite. *Paratetranychus pilosus* Can. and Franz. has long been known in California as the citrus red spider, *Tetranychus citri* Mc.Gregor or more often as *T. mytilaspidis* Riley. It occurs in the southern part of the state as a pest both to citrus and deciduous fruit trees, while in the central and northern Coast Counties, it is chiefly a pest of such deciduous fruit trees as almond, apple, prune, peach, pear, cherry, etc. and passes the winter in the egg-stage on the same.

The mite has apparently been widely distributed throughout the country, since the eggs are so easily and obscurely carried on nursery stock, but it will probably not become a pest in all localities. Besides California it is recorded from the West in Oregon by Dr. H. E. Ewing and in Idaho by R. H. Smith.

Specimens of eggs and mites of the western form could not be distinguished from the European Red Mite by Dr. Philip Garman, who examined the material for us.

E. O. Essig

Nicodust composed of lime treated with 5% of the 40% Nicotine sulphate is proving very efficient in controlling young caterpillars, such as the leaf-rollers, tent-caterpillars and cankerworms, but must be used before the worms are half-grown.

E. O. ESSIG

The Foot Louse of Sheep. *Linognathus pedalis* Osborn, has been taken in the Sacramento Valley, California, a number of times during the past year and seems to be on the increase.

E. R. DE ONG

Arsenate of Lead Spray for Plum Curculio Kills Grasshoppers. The large winged American Locust, *Schistocer a americana* Scud., has been very numerous in the peach belt of Georgia during the latter part of April, and considerable damage has been done by the feeding of this insect on small green peaches. In many orchards fruit on every tree could be found damaged by the feeding of this locust. In one orchard the damage was so severe that poisoned bran bait had to be resorted to. Most of the feeding was observed just prior to the third arsenate of lead treatment for the curculio. Observations made four days after the lead arsenate had been applied at the rate of four pounds of the powder to the two hundred gallon tank for the curculio showed that the treatment was also effective against these locusts. Many dead ones were found on the ground, and appendages of some that had been partially destroyed by ants were also observed. There was hardly a live locust to be found in these orchards after the arsenate of lead had been used.

OLIVER I. SNAPP, *Entomologist,*
U. S. Bureau of Entomology,
Fort Valley, Georgia

Mosaic and Curly Leaf Diseases of Sugar Beets.—In the September number of Phytopathology, pages 349–365, W. W. Robbins published an article entitled, "Mosaic Disease of Sugar Beets." A summary of his article follows: "1. Mosiac of sugar beet has become increasingly prevalent the last few years in steckling and seed beet fields of northern Colorado and western Nebraska. It also occurs in commercial beet fields near possible source of infection. 2. Mosiac of sugar beet is distinct from curly-top of sugar beet. 3. The principal symptom is mottling of the leaves, which may or may not be associated with their malformation. 4. Aphids carry the infectious principle. 5. Under greenhouse conditions, an incubation period on seed beets of approximately 24 days has been established; on seedling plants from 12–18 days. Thus far, evidence of seed transmission is lacking. 7. The virus retains its vitality in the steckling throughout the silo period. This is the only means of wintering-over thus far known."

In California, P. A. Boncquet described in Phytopathology VII, No. 4, pages 269–289, two types of diseases; namely, mottled leaf and black edge or black tip of sugar beets. These two types of diseases are symptoms and malformations of sugar beet mosaic, according to Robbins description and illustrations.

Evidence to support Robbin's view that sugar beet mosaic is distinct from curly leaf may be worthy of mention. Successive generations of non-infective beet leafhoppers (*Eutettix tenella* Baker) have been bred on mottled leaf, and black edge or black tip beets, and the hoppers were then transferred to healthy beets but not a single case of curly leaf developed. On the other hand, when infective leafhoppers were allowed to feed on mottled leaf and black edge or black tip beets, typical curly leaf symptoms appeared. It is evident, furthermore, that *Eutettix tenella* is not able to transmit mosiac of sugar beets.

HENRY H. P. SEVERIN, Ph.D.
California Agricultural Experiment Station

JOURNAL OF ECONOMIC ENTOMOLOGY

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JUNE, 1922

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, provided that at least 100 reprints be ordered at full price rates; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

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The utility of large scale control work is likely to be tested in a most searching manner within the next few years, particularly in relation to the possibilities of checking the spread or controlling such insects as the Japanese beetle, the European Corn Borer and the Gipsy Moth. The first named presents an exceedingly difficult problem, since the adult is very resistant to poisons and flies readily while the subterranean grubs are nearly inaccessible. The European Corn Borer, although it was presumably brought into the country only about ten years ago, has become thoroughly established over considerable areas and here there may be almost unsuspected natural agents which have greatly facilitated the dissemination of the insect, not to mention the slow and practically inevitable spread due to what may be considered the normal flight of the insect. There is, furthermore, the gigantic problem of effectively preventing spread by artificial agencies along very extended lines of defense. The Gipsy Moth with its relatively slow increase now presents a condition somewhat analogous to that of the European Corn Borer in that the border line of the infested area has become greatly extended with indications of still greater expansion by normal spread, not to mention the danger of transportation by commercial agencies. There are obvious limits to artificial methods of checking dissemination and the same is true in a general way at least in relation to the size of areas over which broad scale, repressive measures can be conducted economically. Questions in relation to the control of these insects and also as to the value of different quarantine measures are becoming more insistent with the increase in infested areas and in the case of certain of the above mentioned species at least, there must soon be a determination of the practical limitations and modifications in policy to meet the changed conditions.

Book Reviews

Insects and Human Welfare. By CHARLES THOMAS BRUES, Harvard University Press, Cambridge, Mass., 1920.

The author states in the preface that "the present volume is an attempt to present some of the principles and practices of economic entomology in a form that will illustrate the biological relationships of insects to their environment." It contains five chapters, as follows:—Introduction; Insects and the Public Health; Insects and the Food Supply; Forest Insects; Household Insects; The Outlook for the Future. This interesting and attractive little volume contains 104 pages, 42 text figures, and is bound in red cloth. The addition of an index would have greatly increased its value as a reference work.

W. E. B.

Report of the Proceedings of the Fourth Entomological Meeting Held at Pusa, February 7-12, 1921. Edited by T. BAINBRIGGE FLETCHER, Imperial Entomologist, Government Printing Office, Calcutta, India, 1921.

The meeting reported was attended by over forty entomological workers from India and Ceylon, and fifty papers read at the meeting are included in this volume. Most of these papers (twenty-one) deal with crop pests, but there are eight on medical and veterinary entomology, nine on life histories and bionomics, four miscellaneous, two each on lac, and systematic entomology, one each on forest entomology, stored grain insects, and publications.

This report is an interesting and well printed volume of 401 pages with index, and LVII plates, eight of which are colored, and a frontispiece showing those in attendance at the meeting. It is bound in green board covers, with cloth back and corners, and is a valuable addition to the literature of Indian entomology.

W. E. B.

Annales des Epiphyties. Tome VII, Memoires et Rapports, en 1919 et 1920. MAURICE-MENDEL, Editeur, Libraire Speciale Agricole de l'Institut Agronomique, 58 Rue Claude-Bernard, Paris, 1921.

This publication of 461 pages, and many figures and plates which are not numbered consecutively, contains reports of researches and observations as follows:—Rapport phytopathologique pour les Années 1919-1920, par P. Marchal, Directeur de la Station Entomologique de Paris, et E. Foex, Directeur de la Station de Pathologie Végétale de Paris; Étude sur les Champignons Parasites, par G. Arnaud, Sous-Directeur de la Station de Pathologie de Paris; Le Criquet Marocain en Crau en 1920, par P. Vayssiére, Directeuradjoint de la Station Entomologique de Paris; Les Traitments Simultanés contre les Maladies Crytogamiques et les Insectes Parasites des Arbres Fruitiers par les Bouillies Mixtes, par A. Paillot, Directeur de la Station Entomologique de Sud-Est; Essais de Bouillies Mixtes pour le Traitement des Arbes Fruitiers, par J. Feytaud, Directeur de la Station Entomologique de Bordeaux; La Fourmi d'Argentine, *Iridomyrmex humilis* var. *arrogans* Santschi,

dans le Midi de la France, par C. Chopard, Secrétaire de la Société Entomologique de France; Mission d'Études sur les Maladies de la Pomme de Terre en France, par MM. Quanjer et Foex; La Maladie de l'Enroulement de la Pomme de Terre, par Et. Foex, Directeur de la Station de Pathologie Végétale de Paris; Sur le Perfectionnement de la Pomme de Terre et sa Résistance aux Maladies, par J. Aumiot, Docteur es-sciences; La Maladie de l'Enroulement de la Pomme de Terre, par E. Blanchard, Directeur des Services Agricoles de Seine-et-Oise, et Cl. Perret, Directeur du Champ d'Expériences de Merle; Sur les Maladies des Pommes de Terre, par. Cl. Perret, Directeur du Champ d'Expériences de Merle; Les Maladies Cryptogamiques des Abricotiers dans la Vallée du Rhone, par J. Chifflot, Inspecteur Phytopathologique; Recherches sur l'Eudémis et la Cochylis dans le Bordelais en 1918 et 1919, par J. Feytaud;Les Insectes Nuisibles aux Cultures du Maroc, par Paul Vayssière; La Station Entomologique de Rouen, par Robert Régnier, Chef de Travaux de la Station de Rouen; Un Ennemi du Peuplier, *Idiocerus populi* Linn., ou Cicadelle du Peuplier, par Robert Régnier: La Question des Corbeaux en Normandie, par Robert Régnier; Observations Biologiques sur la Mouche des Olives et ses Parasites dans la Région de Menton, par R. Pontiers, Chef des Travaux, et L. Turinetti, Préparateur, à l'Insectarium de Menton; Recherches sur l'Emploi de la Chloropicrine comme Insecticide Agricole, Travaux effectués par P. Schindler, Ingénieur-Agronome, et par B. Trouvelot, Ingénieur -Agronome, Préparateur à la Station Entomologique de Paris, Rapport de B. Trouvelot; Les Maladies du Melon, par J. Dufrénoy, Ingénieur-Agronome; Rapports Sommaires sur les Travaux Accomplis dans les Laboratoires et Comptes Rendus des Missions d'Études: Laboratoires,—Station Entomologique de Paris et Insectarium de Menton,—Rapport de M. Paul Marchal, Directeur; Station de Pathologie Végétale de Paris.—Rapport de Et. Foex, Directeur; Station entomologique de Blois.—Rapport de M. L. Gaumont Chef des travaux; Station entomologique de Bordeaux.—Rapport de M. J. Feytaud, Directeur; Station entomologique de Montpellier.—Rapport de M. F. Picard, Directeur; Station entomologique de Saint-Genis-Laval.—Rapport de M. A. Paillot, Directeur; Station entomologique de Rouen.—Rapport de M. R. Régnier, Chef des travaux; Index.

W. E. B.

The Italian Pear Scale on Nursery Stock. The Italian pear scale, *Epidiaspis piricola* (Del Guercio), normally feeds on the bark of the trunk and limbs of the trees and hides under moss, lichens or scaly bark wherever the opportunity offers. In feeding it may cause small pits or depressions in the larger limbs, which may crack or become dead sunken areas, especially on old trees where the insect has occurred for many consecutive years. This scale is not widely distributed in California as an orchard pest, being largely confined to the Santa Clara Valley and adjacent territory, though it may be found in other parts of the state where it commonly attacks apple, prune and pear trees. Recently the scale was found on Myrobalan nursery stock at Gilroy. The attack was different from that on older trees in that the scales were found imbedded in the trunks of the seedlings just above the surface of the ground. In feeding they had caused large, deep, dimple-like depressions in the bark. At the bottom of each depression, and almost completely hidden, were from two to three scales. It may be said that these trees passed nursery inspection in two counties and such infested stock is an easy way to disseminate the pest because the scales are easily overlooked in the depressions.

J. F. LAMIMAN

Current Notes

Mr. A. F. Burgess visited Hartford, Conn., on April 6, for a conference on gipsy moth work.

Prof. Herbert Osborn visited Washington, D. C., the latter part of April, and stopped on the way at Harrisburg, Pa.

Dr. J. M. Swaine addressed the Biological Club, MacDonald College, on Friday evening, February 10, on "Forest Insect Injuries in Canadian Forests."

Mr. S. Willard Harman has been appointed research assistant in entomology at the Agricultural Experiment Station, Geneva, N. Y., vice Clarence R. Phipps, resigned.

Prof. J. A. Manter of the Connecticut Agricultural College, Storrs, Conn., has been in the Hartford Hospital nearly all winter receiving treatment for blood poisoning.

According to *Science*, Mrs. Anna Botsford Comstock, who retired in September from a professorship in entomology at Cornell University, has been nominated for election as alumni trustee.

According to *Science*, Dr. E. B. Poulton, Hope professor of zoology at Oxford, was elected president of the British Association of Economic Entomologists at the annual meeting, February 24.

Mr. J. D. Mitchell of Victoria, Texas, died February 27, 1922. He was an all round naturalist, and has been connected with the U. S. Bureau of Entomology since 1904.

Mr. W. M. Mingee, field assistant in insect control, employed on truck crop insect investigations since 1919, and stationed at Ocean Springs, Miss., has resigned to engage in business.

The corn borer laboratory of the Bureau of Entomology located at Scotia, N. Y., has been moved to 1120 Fifth St., Sandusky, Ohio. Mr. J. H. Harmon will be in charge.

Mr. George D. Smith of the Bureau of Entomology has resigned to accept the position of associate entomologist of the Florida State Plant Board. His headquarters will be at Madison.

The following transfers in the Bureau of Entomology have been announced: J. N. Tenhet, Clarksville, Tenn., to Quincy, Fla.; E. R. Van Leeuwen, camphor scale investigations to apple insect investigations at Medford, Ore.

Prof. W. C. O'Kane visited New York April 20th, in connection with the work of the Crop Protection Institute and stopped in New Haven for a few hours on his return.

The Pennsylvania Department of Agriculture announced that it would inaugurate on May 1st, a radio broadcasting service which will include timely advice on the control of insects and plant diseases.

Dr. L. O. Howard is the author of a chapter entitled "A Fifty-Year Sketch History of Medical Entomology," published in the Jubilee Volume of the American Public Health Association, "Half A Century of Public Health," issued last November. This article will be reprinted in one of the annual volumes of the Smithsonian Institution.

Mr. Clarence R. Phipps, assistant in entomological research, Agricultural Experiment Station, Geneva, N. Y., resigned January 1, 1922, to accept a similar position at the Missouri Fruit Experiment Station, Mountain Grove, Mo.

Mr. D. L. Van Dine, Bureau of Entomology, who has been engaged in investigations of malaria and mosquitoes at Mound, La., has resigned to accept, May 15, a position at the Pennsylvania State College.

Mr. Arthur Gibson, Dominion Entomologist of Canada, has recently been elected a Fellow of the Royal Society of Canada. He is also treasurer of the John Macoun Memorial Committee of the Ottawa Field Naturalists' Club.

The field laboratory of the Bureau of Entomology at Carlisle, Pa., has been moved from 227 Moreland Avenue to the Kronenberg Building on Hanover Street. Mr. P. R. Myers will continue in charge.

Mr. J. J. McNeil, who has been in charge of the auditing and accounting work of the Federal Insecticide and Fungicide Board, resigned April 24, to accept a position in the Fruit Growers Express Co.

Dr. J. D. Tothill of the Canadian Entomological Branch, spent a part of February in Boston, visiting the Corn Borer and Gipsy Moth Laboratories with particular reference to the natural control of these insects.

Mr. R. P. Gorham of the Canadian Entomological Branch has completed the index for the third volume of the report of the Canadian Arctic Expedition, which deals with the insects collected on the trip.

Mr. H. J. Dodd has been appointed field assistant in the Bureau of Entomology, and assigned to duty at Fort Valley, Ga., on life history studies of the plum curculio and other peach insects.

Mr. E. R. Selkregg of the Bureau of Entomology, who has been in charge of life history work in connection with the peach insect investigations at Fort Valley, Ga., has resigned to enter commercial work.

Dr. Vernon L. Kellogg of the National Research Council was scheduled to speak on "The Power and Importance of Man" at the reception of the American Philosophical Society on Friday evening, April 21, in Philadelphia.

The Bureau of Entomology has established a new laboratory at Sligo, Md., where especial attention will be given to the subject of insecticides and biological studies of fruit insects. Mr. E. H. Siegler is in charge.

According to *Science*, on March 2, Prof. H. M. Lefroy delivered the first of two lectures at the Royal Institution on (I) "The Menace of the Insect Pest," and (II) "The Balance of Life in Relation to Insect Pest Control."

The entomological department of the Ohio Station has established a laboratory at Chillocothe, with Mr. A. E. Miller in charge. Particular attention will be given to insects attacking truck crops. Prof. H. A. Gossard visited the site on April 4.

Mr. Reginald Hart, an entomologist of experience with tropical insects and formerly connected with the Bureau of Plant Sanitation of Cuba, is now a member of the staff of the Florida State Plant Board, with headquarters at Gainesville.

Mr. C. E. Smith of the Bureau of Entomology, in charge of the Baton Rouge, La., Station, is conducting experiments to control red spider on strawberries at Hammond, La., where in spite of continued heavy rains, a serious infestation is reported.

Dr. F. C. Craighead of the Canadian Entomological Branch, returned on March 25 from Washington, D. C., where he studied the larval stages of the Cerambycidae. On the way he stopped at Harrisburg, Pa., to examine material in the State collection there.

Dr. W. J. Holland, Director of the Carnegie Museum, Pittsburgh, Pa., was elected on March 9 as one of the honorary members of the Entomological Society of Brazil, "in token of their appreciation of the services he has rendered to the science of Entomology."

Dr. L. O. Howard left Washington D. C., Sunday, May 14, for a six-weeks' trip to visit the field stations of the Bureau of Entomology throughout the western states, with particular attention to the field stations for the study of forest insects.

Dr. Thomas Algernon Chapman died at Reigate, Surrey, England, December 17, 1921, in his 78th year. He was a Fellow, and many times Vice-President of the Entomological Society of London, and published a number of papers on Lepidoptera, Coleptera, Diptera and Hymenoptera.

Dr. W. M. Mann of the Bureau of Entomology, who was a member of the Mulford Expedition to South America, arrived in New York April 13, with a large collection of insects and a number of mammals and ethnological specimens which will be placed in the U. S. National Museum.

The officers of the Florida Entomological Society for 1922 are as follows: President, Frank Stirling; Vice-President, Dr. O. F. Burger; Secretary, A. H. Beyer; Treasurer and Business Manager of *Entomologist*, F. M. O'Bryne; Member of Executive Committee, Dr. J. H. Montgomery; Editor of *Entomologist*, Prof. J. R. Watson; Associate Editor of *Entomologist*, Dr. Wilmon Newell.

Prof. E. H. Strickland left Ottawa on February 25 to take up his new duties at the University of Alberta, Edmonton, and on his way spent a month at Amherst, Mass., on systematic work and investigating the methods of teaching economic entomology. He also spent a few day in Boston and New York.

Dr. A. D. Hopkins of the Bureau of Entomology gave an address April 11, on "Insect Depredations in the Maine Woods," before the American Paper and Pulp Association at the Waldorf Astoria, in New York. He dwelt especially on the outbreak of spruce bud worm in the New England States and Canada, which is just now causing considerable concern.

An extensive outbreak of *Dendroctonus* in spruce was reported some time ago from the Porcupine Forest Reserve in northern Saskatchewan. The affected area was cruised by the Forestry Branch and the reports indicate that the injury is severe. The outbreak is probably caused by the same species of beetle which is affecting the spruce in the Gaspe Peninsula.

Mr. J. E. Graf of the Bureau of Entomology in charge of field control of Mexican bean beetle, is visiting Mountain Air and other points in New Mexico, to secure data on the hibernation of this beetle in the Rocky Mountain plateau regions. In the Estancia Valley the Mexican bean beetle caused a loss in 1921, which has been estimated at $100,000.00.

Mr. E. P. Felt, at the request of the Entomological Club of Madison, Wis., gave a radio phone lecture on April 24, at 9 o'clock P. M., Eastern Standard Time, on the subject of "Bugs and Antennae." This lecture was broadcasted from the sending station of the General Electric Company, Schenectady, N. Y., and was heard by a number of entomologists in the eastern states.

Mr. H. G. Crawford of the Canadian Entomological Branch addressed the Lambton County Corn Growers on the subject of the European Corn Borer about the middle of February. On March 6, he returned from his annual leave of absence, having spent several days at the U. S. Corn Borer Laboratory, Arlington, Mass., in consultation with Mr. Caffrey and other members of the staff.

According to *Science*, the Board of Regents of the University of Minnesota have granted Prof. F. L. Washburn, of the division of entomology and zoology, a six months' sabbatical furlough to collect insects in certain islands of Polynesia, especially Tahiti, Murea, and probably the Marquesan and Cook groups. The expenses are provided for through private funds furnished by business and professional men of Minneapolis, and the collections will become the property of the University.

Entomological News for May contains an obituary notice of Dr. Joseph Lane Hancock, who died in Chicago March 12, 1922. He was born in Chicago, April 12, 1864, and though he distinguished himself as artist, author and physician he was also a naturalist, and published many papers on the Orthoptera. His collection was an extensive one and has been purchased and is now a part of the Morgan Hebard collection deposited at the Academy of Natural Sciences, Philadelphia.

The following recent appointments in the Bureau of Entomology are announced: Maurice E. Phillips, a graduate of the University of West Virginia who recently received his M. S. degree from Cornell University, has been appointed junior entomologist to investigate insects attacking dried fruits and vegetables, Fresno, Calif; H. A. Jaynes, a graduate of the Connecticut Agricultural College, junior entomologist, assigned to Japanese beetle project, Riverton, N. J.; J. A. Harris, a graduate of the Mississippi Agricultural College, field assistant, assigned to plum curculio and other peach insect investigations, Fort Valley, Ga.; H. H. Link, formerly employed in the Bureau, field assistant, citrus fruit insect investigations, Orlando, Fla.

Mr. E. G. Smyth, formerly chief entomologist of Porto Rico, and connected with the Bureau of Entomology as entomological assistant from 1908 to 1913, as extension entomologist from 1917 to 1918, and as collaborator during 1921, has been appointed as special field agent to undertake a trip to southern Mexico with the hope of discovering parasites of the Mexican bean beetle suitable for importation into the United States. Mr. Smyth will proceed by way of Birmingham, where he will stop over for consultation with Bureau employees, and thence to Mexico by rail, where six months will be spent in investigations of the Mexican bean beetle and related types with particular reference to parasites and factors affecting the economic importance of this pest in its native habitat.

A regional conference of Canadian and American entomologists was held April 12 and 13 at Minot, N. D., where a full discussion of the international phases of the investigations of the pale western cutworm, grasshopper problems, and the western wheat-stem sawfly was had. As a result of this conference, it was decided to conduct a series of experiments, both in Canada and the United States, on a uniform basis, so as to render the results easily comparable. It was also decided to construct an international map, including in this several of the northwestern States in the United States as well as those Canadian provinces which are most seriously involved in grasshopper outbreaks. The purpose of the map is to record and visualize grasshopper conditions in a large, regional way and to form a basis for annual records of such conditions from year to year. Those attending the conference were: Norman Criddle and A. V. Mitchener of Manitoba, H. L. Seamans of Alberta; M. P. Tullis, field crop commissioner for Regina, Saskatchewan; A. L. Strand, representing Montana; Prof. A. G. Ruggles, representing Minnesota; Prof. R. L. Webster of North Dakota; and W. R. Walton, Stewart Lockwood, Alfred Eastgate, and C. N. Ainslie, of the Bureau of Entomology. It was decided to attempt to hold a similar conference in Winnipeg about the same time next year, as the results of the conference were considered to be of the utmost value. The title adopted by this group is "International Northeastern Committee on Insect Pests."

Horticultural Inspection Notes

An office has been secured in the Customs Examining Warehouse, Toronto, for the inspector in charge of the Toronto district.

Canadian Quarantine No. 2 dealing with the European Corn Borer, was passed on February 10th; this revision brings the quarantine up to date, and places a double quarantine on the counties of Elgin and Middlesex.

A conference of southern state inspection and transportation officials, nurserymen, and representatives of growers' organizations has been called for at Atlanta, Georgia, on May 30 and 31, for the purpose of considering uniformity of inspection practices in the southern states.

On February 7th, amendment No. 13 to the Canadian Regulations under the Destructive Insect and Pest Act was passed, which added a list of injurious insects, such as the Japanese Beetle, Mexican Bean Beetle, etc., to Section 18 of the Regulations.

A colored map showing the area quarantined for the European Corn Borer has been prepared by the Natural Resources Intelligence Branch of the Canadian Department of the Interior, and has been distributed to all the transportation companies, corn growers, etc., in the quarantined district.

Information has just been received to the effect that Dr. Paul Marchal, who for years has been the Chief Phytopathological Inspector of France, has resigned. His successor has apparently not been appointed, but all communications should be addressed to Monsieur le Ministre de l'Agriculture, (Service phytopathologique), 78, rue de Varenne, Paris, VII.

Mr. R. Owen Wahl, Entomologist and Zoologist of the School of Agriculture, Middleburg (Cape), South Africa, has for several weeks been visiting the various ports of entry at which inspectors of the Federal Horticultural Board are stationed, for the purpose of studying the methods and procedure followed in port inspection, fumigation, and sterilization work.

Interesting interceptions made at the port of New York during the months of March and April included the Papaya fruit fly (*Toxotrypana curvicauda* Gerst) in mango fruit from Jamaica, the woolly white fly (*Aleurothrixus howardi* Q.) on banana leaves from Porto Rico by Inspector Emile Kostal, and *Aleurothrixus floccosus* on citrus leaves from Porto Rico by Inspector R. G. Cogswell.

As a result of the arrival of shipments under special permit, at Washington, D. C., during the early spring months, it was necessary to take on two additional inspectors to assist in the examination of this plant material. Inspectors J. L. Bottimer and W. E. Conn, who are engaged in the Clean-Up Work under the direction of Dr. W. D. Hunter, were temporarily transferred to Washington.

Apple stock from Czecho-Slovakia arriving at the Inspection Office in Washington in April, proved to be infested with the Apple Stem Piercer, *Magdalis barbicornis* (Latr.). The insects at the time of arrival, were for the most part in the pupal stage, although adults appeared within a short period. This weevil in Europe is reported to attack, in addition to apple, quince and medlar trees.

On March 28, Inspector U. C. Zelluff, stationed at Tampa, Florida, discovered a passenger leaving a steamship arriving from Havana, with four potted avocado trees. Upon inspection, these trees were found to be infested with the Citrus Black Fly. This appears to be a flagrant attempt on the part of a Florida resident to

violate the provisions of the Plant Quarantine Act of 1912, since a permit to import plants had not been requested.

Mr. George M. List of Colorado reports that a florist of Loveland, Colorado, recently experienced the entire loss of his Easter Lilies due to an attack of the Bulb Mite (*Rhizoglyphus hyacinthi*). A relatively small percentage of the infested plants developed blossoms, and many of the plants were entirely destroyed. The Bulb Mite is constantly being intercepted on introduced bulbs, and it is almost safe to assume that every large shipment of European bulbs is infested by this mite to a greater or less extent.

A recent shipment of broom corn infested with the European Corn Borer arrived in New York from Hungary. A careful examination was made of a representative number of bales, and it was determined that not more than one per cent. of the stalks was infested with the larvae of this insect. The shipment was promptly sterilized with live steam at the plant of the Pan-American Fumigating Company at Brooklyn, New York, under the direct supervision of Inspectors L. C. Griffith and H. G. Frank of the Federal Horticultural Board.

The Citrus Black Fly continues to be collected on foliage arriving at Key West. Inspectors L. R. Warner, W. V. Millington, and J. V. Gist of the Florida State Plant Board made interceptions in the months of January, February and March. To illustrate the thoroughness with which these men are performing their work, one of the interceptions consisted of the finding of egg spirals on leaves attached to a jasmine sprig which was pinned on the fur of a woman's coat. The same insect has been collected by Mr. Merle R. Brown, also of the Florida State Plant Board, on sapodillas arriving at Miami, Florida, from Nassau.

The conference which was held by the Federal Horticultural Board in Washington on May 15, was well attended. Delegates representing florists, nurserymen, growers, importers, and amateurs were present, as were officials from the following foreign countries: France, Jacques Courtine, Bulb Growers and Exporters Syndicate of Toulon; Belgium, Charles Pynaert, President, Chamber of Horticulture, and Louis Sander of Sander and Fils, Horticulturists; Holland, N. van Poeteren, Chief, Phytopathological Service, and E. van Slgteren, Phytopathologist for the Bulb District of Holland; England, W. G. Lobjort, Comptroller of Horticulture. Officials from the following states were in attendance and took part in the discussion: California, Texas, Florida, Georgia, Michigan, Maryland, Pennsylvania, New Jersey, Alabama, and Connecticut.

Mr. H. F. Dietz of Indiana reports that there are two rose diseases causing considerable damage in the State of Indiana at the present time; namely, cane blight (*Coniothyrium fuckelii*) and crown gall. The former has been especially troublesome over a period of at least two years. Mr. Dietz is of the opinion that the disease gains entrance to the plants through the pruning wounds and may possibly be spread by infected shears or knives. In young and vigorous plants, the disease usually stops at the first node, forming a canker. Plants over two years of age which have been weakened as a result of forcing, are apparently more seriously affected, the disease occasionally killing long canes and at times the entire plant. Crown gall is especially troublesome on the varieties Ophelia and Sawyer grown on their own roots. Affected plants do not give good results when forced, nor do they yield readily to cultural treatment.

On March 21st, the following regulations to the Canadian Destructive Insect and Pest Act were passed: Amendment No. 14. Prohibiting the importation of currants and gooseberries from all countries, except from the State of New York into

the province of Ontario. Amendment No. 15. Prohibiting the importation of certain plant products from those areas in the United States infested by the European Corn Borer, unless the same are accompanied by a certificate of inspection. Amendment No. 16. Prohibiting the importation of potatoes from the countries mentioned under subsection (a) of section 7 of the regulations, as well as from the states of Pennsylvania and West Virginia on account of the potato wart disease. Amendment No. 17. Prohibiting the importation of alfalfa hay from those areas in the United States infested with Alfalfa Weevil. Amendments number 14 and 16 were passed upon the recommendation of the Division of Botany and will be administered in co-operation with that Division.

It has been determined as a result of the inspection of express, mail, and freight shipments containing nursery stock from various states by Messrs. L. L. Spessard and H. L. Sanford, inspectors of the Federal Horticultural Board located in Washington, D. C., that a number of the nurserymen have been making it a practice to utilize invalid certificates, some of which are a year or more out of date, others which do not indicate the date on which the certificate becomes invalid, and in many instances, certificates which have been corrected. These irregularities have been brought to the attention of the various state officials responsible for the certification of the plant material in question. The above applies to practically every state forwarding plants in any numbers to Washington, and it is therefore probably safe to assume that invalid certificates are being used in a very large percentage of the states. This is a matter which should receive the attention of all state officials certifying stock for distribution.

Figures recently compiled indicate that 97 foreign shipments of plants have been found to be infested with one or more nests of the Brown-Tail Moth from August 20, 1912 up to and including April 22, 1922. These interceptions were as follows: France 95 (Apple 27, Cherry 9, *Crataegus* sp. 1, *Crataegus oxyacantha* 1, *Crataegus flora* 1, *Cydonia oblonga* 10, Fruit stocks 14, Pear 11, Purple barberry 1, Cotoneaster 2, *Fagus sylvatica* 1, Rose 6, Plum 3, *Pinus mughus* 1, *Prunus pissardi* 1, *Sorbus aucuparia* 1, Unknown plant 5); Holland 1 (Fruit seedling 1); Ireland 1 (Rose 1). The number of species of insects and plant diseases intercepted on introduced plants from the eight principal exporting countries from August 20, 1912 up to and including April 22, 1922, follows: Belgium—Insects 73, Plant Diseases 18; England—Insects 104, Plant Diseases 4; France—Insects 153, Plant Diseases 17; Germany—Insects 25, Plant Diseases 4; Holland—Insects 167, Plant Diseases 31; Ireland—Insects 21, Plant Diseases 0; Japan—Insects 214, Plant Diseases 29; Scotland—Insects 14, Plant Diseases 0.

Two Mealy Bugs Found in Ant's Nests. *Pseudococcus longisetosus* Ferris. This mealy bug was first found associated with ants in San Mateo County, California by Mr. Ferris of Stanford University who described it as a new species. He also found it near Stanford University on the underground stems of *Castilleia foliolosa*, and *Orobanche tuberosa* and from the roots of *Armeria vulgaris* near Pacific Grove. The writer recently found this mealy bug associated with ants on roots of Poison Oak, (*Rhus diversiloba*) in Niles Canyon.

Phenacoccus colemani Ehrh. was described from *Rubus* sp., near Palo Alto, California and has been found associated with ants near Stanford University. Dr. E. C. Van Dyke found this species associated with ants near Redwood Peak, Alameda County. The writer found the same mealy bug on Cypress Ridge, Marin County, where it was associated with ants under rocks and feeding on grass roots.

J. F. LAMIMAN

Apicultural Notes

The East Tennessee Beekeepers' Association now has 111 members and will hold its fifth annual convention at Knoxville on May 17.

The black locust blossom has been abundant in Tennsesee. White clover is beginning to blossom on May 9. Bees generally are doing well.

It is reported that 62 students are enrolled in the course in beekeeping at the Colorado Agricultural College at Fort Collins, Colo.

Dr. E. F. Phillips of the Bureau of Entomology has recently been elected an honorary member of the Beekeepers' Association of South Africa, and honorary vice-president and Fellow of the Apis Club, an international organization with headquarters in Benson, Oxon, England.

Mr. W. L. Walling, who has been spending the winter in Knoxville, Tenn., and giving several lectures to the apicultural classes of the University of Tennessee, has returned to his beeyard at Hardin, Montana. Last year Mr. Walling produced 18,500 pounds of honey.

Dr. G. F. White, specialist in insect diseases, Bureau of Entomology, has been elected a Fellow of the Apis Club, Benson, Oxon, England. In transmitting the notice of election, the secretary said "It is the highest position of distinction that is within our power to offer to a benefactor in beekeeping."

A series of beekeepers' meetings was held at Jackson, Lexington, Dyersburg and Memphis, Tennessee, on April 25, 26, 27 and 28 respectively. Much interest was shown in these meetings by the beekeepers who have asked that a West Tennessee Beekeepers' Association be perfected at the next meeting of the Farmers' Institute to be held at Jackson.

Prof. R. O. Wahl, entomologist of the Grootfontein Agricultural School, Middleburg, Cape Colony, South Africa, has recently made a trip through Canada and the United States. He visited Ottawa April 5 and 6, and spent the 24th and 25th at the Ohio Station, Wooster, Ohio. He spent a week at Medina, Ohio, to study American beekeeping methods and equipment. He is a friend and co-worker of C. W. Mally who was assistant entomologist at the Ohio Station from 1898–1902. After leaving the United States, Prof. Wahl expects to visit Honolulu and Australia.

Following the conference held in Washingtom March 9th, a bill was drafted prohibiting the importation of adult bees into the United States except for scientific purposes by the U. S. Department of Agriculture, and except from countries having no diseases dangerous to adult bees under rules and regulations prescribed by the Secretary of the Treasury and the Secretary of Agriculture. This bill was introduced into both Houses of Congress and at the time of this writing has been unanimously reported on favorably by the House Committee on Agriculture. The bill seems to have met with almost universal favor among beekeepers, the only opposition having come from those interested in future importations of races other than the Italian. The Minister of Agriculture of the Dominion of Canada has issued an order prohibiting the importation of bees from Europe and the Dominion of Australia has a similar order applying only against Great Britain. Both are, of course, designed to prevent the introduction of the Isle of Wight disease into these countries. The March number of Schweizerischer Bienenzeitung announces the finding of the mite causing the Isle of Wight disease in Switzerland.

The annual meeting of the Connecticut Beekeepers' Association was held at the Capitol, Hartford, April 29. About 125 were present. The following officers were reelected: President, Henry L. Lankton, Wethersfield; Secretary and Treasurer, Louis St. Clair Burr, South Manchester.

Beekeeping seminars are held regularly on the second and fourth Friday evenings of each month at the Bee Culture Laboratory, Somerset, Maryland. Visiting entomologists and beekeepers are welcome. The following subjects have been discussed in these seminars since they were instituted: E. F. Phillips, Digestion of Carbohydrates by the Honeybee; A. P. Sturtevant, Hydrogen-ion Concentration; R. E. Snodgrass, Metamorphosis in Insects; W. J. Nolan, Brood-rearing during the Season; E. L. Sechrist, Tropical Beekeeping; P. B. Dunbar, The Food and Drugs Act.

Pacific Slope Notes

E. O. Essig will take a group of entomological students of the University of California for a six weeks' stay in the Santa Clara and Pajaro Valleys where a practical study of orchard and field insects will be made during the summer.

Mr. John Lamiman who graduates in entomology at the University of California this year, has been appointed a member of the entomological staff to investigate orchard insects with particular reference to codling moth and peach borer.

Mr. C. T. Dodds, a graduate student in Entomology at the University of California, will spend the summer in Mexico assisting Mr. Zwalenburg in the introduction and rearing of parasites to control the sugar cane borer. He expects to continue his work at the University in the fall.

Mr. Claude Wakeland, formerly extension entomologist of Idaho, has been appointed Experiment Station Entomologist, University of Idaho, with temporary headquarters at Rexburg, Idaho, and Mr. Don B. Whelan succeeds Mr. Wakeland as extension entomologist at the University.

In a recent letter received by Professor Herms from Professor C. W. Woodworth now in Nanking, China, there are many items of interest, among them the news that he has organized a fly and mosquito campaign for that city and has been made a special member of the Police Department and has a special office in the Yamer of the Chief. Professor Woodworth has also had constructed a boat laboratory 48 feet long and 11 feet wide, naming it the "Dragonfly," and the twenty horsepower motor launch used to tow the same, is named the "Cicada." His organization of the Kiangsu Province Bureau of Entomology is evidently progressing satisfactorily.

Notes on Medical Entomology

According to *Science*, Sir Ronald Ross has been elected a member of the Athenaeum Club for "distinguished eminence in science."

Sir Patrick Manson distinguished for his work on malaria and tropical diseases, died on April 8, at the age of 76 years.

Dr. Seymour Hadwen, chief veterinarian and parasitologist of the U. S. Biological Survey, who has just completed an eighteen month's study of reindeer in Alaska, sailed for England April 16, to continue his studies.

Mr. G. F. Moznette of the Bureau of Entomology with headquarters at Miami, Fla., addressed the local Kiwanis Club on March 23, the Rotary Club on April 6, and the Chamber of Commerce on April 14, on the Miami mosquito problem and methods of ridding the city of the mosquito menace. These talks were a part of the program for arousing public support for the city's campaign against mosquitoes.

He urged the co-operation of clubs, churches and schools in eliminating the mosquito in that region.

The first New England Health Institute was held at Hotel Bond, Hartford, Conn., May 1-6. The health departments of all the New England States co-operated with the U. S. Public Health Service and the medical schools of Harvard and Yale Universities. Between 500 and 600 were registered to take the courses and the New England States were all represented. The faculty consisted of 77 lecturers, Dr. John T. Black, Health Commissioner of Connecticut was Director, and Dr. W. E. Britton lectured on Wednesday, May 3, on "The Role of Insects in the Transmission of Human Diseases."

At a meeting of the Board of Directors of the Gorgas Memorial Institute, at Washington on April 1, announcement was made that the Panama Government had provided a site for the proposed Gorgas Institute of Tropical and Preventive Medicine. The site is adjacent to the St. Thomas Hospital, which contains laboratories and buildings and represents a cost of approximately $500,000.00 Dr. Richard Strong, professor of tropical medicines at Harvard University, has been elected director of the Institute. The board also announced the selection of the directors of the Gorgas School of Sanitation to be established at Tuscaloosa, Ala. They are: Dr. S. W. Welch, of Alabama; Dr. Charles F. Dalton, of Vermont; Dr. A. J. Chesley, of Minnesota; Dr. E. G. Williams, of Virginia; Dr. Lloyd Noland, medical director of the Tennessee Coal and Iron Company, and J. A. LaPrince representing the United States Public Health Service. This board will meet at Tuscaloosa during the last week in May and arrange the courses. At that time they will also probably elect a faculty.

The work of the Bureau of Entomology against malarial mosquitoes is now in direct charge of Dr. W. V. King, who has been engaged in medical entomological work for the Bureau for many years. He graduated from the Montana Agricultural College, and soon was employed in investigating the Rocky Mountain spotted fever. Afterward he was associated with the late A. H. Jennings in investigating the possible insect transmission of pellagra, at Spartansburg, S. C., and in New York City, in connection with the extensive investigation of the whole subject of pellagra by the Thompson-McFadden commission. Since the conclusion of the pellagra work, Dr. King has been stationed in Louisiana, at New Orleans and at Mound, where he has studied the relations between the various species of mosquitoes and the different forms of Plasmodium, and various features of malaria in co-operation with the International Health Board.

The dried fruit beetle. *Carpophilus hemipterus* (Linn.) has become a pest of dried fruits in the warmer interior valleys of California. Although it breeds freely in stored dried fruits, it is nowhere as serious as is the Indian meal moth, *Plodia interpunctella* Hbn.

The fig is a favorite food of the beetle and the ripening fruit often becomes infested on the trees, particularly if there is any indication of souring, and in the dry yards and packing houses it may often become a serious problem.

But one of the difficult problems in connection with the insect in question is its relation to the smutting and souring of the ripening fruit in the orchards. The beetle breeds freely in smutty figs and is attracted by soured as well as the sound fruit. During the winter the adults may be found in great numbers in decaying melons infested with the same smut that attacks the figs and also very abundantly in decaying apples and other rotting organic matter.

E. O. Essig